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Abstract

This study exploits policy reforms in Swedish primary care to examine the effect of pay-for-performance (P4P) on compliance with hypertension drug guidelines among public and private health care providers. Providers in regions with P4P are compared to providers in other regions in a difference-in-differences analysis using data from the Swedish Prescription Register for the period 2005-2013. The results indicate that P4P improved guideline compliance regarding prescription of Angiotensin Converting Enzyme (ACE) inhibitors and Angiotensin Receptor Blockers (ARB). The effect is mainly driven by private providers, suggesting that policy makers should take ownership into account when designing incentives for health care providers.

Introduction

Pay-for-performance (P4P), incentives tied to performance targets, has been a popular strategy to improve care quality in many countries. In practice, incentives tied to process measures (e.g., guideline compliance or screening rates) are often associated with small improvements of the performance measure, while incentives tied to health outcomes tend to be ineffective. However, the quality of the evidence is limited and there are comparatively few studies from outside the United States or United Kingdom (Eijkenaar et al., 2013; Herck et al., 2010; Ogundeji et al., 2016). Moreover, although the importance of contextual factors have been pointed out (McDonald et al., 2009), there have been few attempts to examine how providers with different characteristics differ in their reaction to P4P. In particular, although public provision is a key feature of many healthcare systems, there is to the best of our knowledge no study of whether private and public providers respond differently to P4P. Theoretically, one may expect the power of monetary incentives to be weaker for public care providers for at least two reasons. First, public providers lack a profit-maximization motive and often face soft budget constraints (Kornai et al., 2003). Second, public employees may be more driven by intrinsic motivation for their work than private employees, suggesting that external incentives (such as P4P) may be less effective in public organizations (Frey et al., 2013; Georgellis et al., 2011). Nevertheless, there are reasons why publicly employed physicians may not be completely insensitive to P4P. The components of the reimbursement scheme for providers clearly gives a signal of what is prioritized by leading policy-makers (Bénabou and Tirole, 2003; Ellingsen and Johannesson, 2008). Publicly employed physicians with career concerns may therefore respond to the scheme, as it allows them to signal high ability (Holmström, 1999).

This study examines whether private and public primary care providers in Sweden respond similarly to P4P for compliance with hypertension drug guidelines. The Swedish primary care setting provides an excellent ground for studying such heterogeneity, as almost half of all providers are publicly owned. However, of the three existing studies of P4P in Sweden, none of has addressed the potentially different responses across public and private providers. The previous Swedish studies indicated P4P is associated with improvements of process measures such as antibiotics guideline compliance (Ellegård et

al., 2018), registrations in a diabetes quality register (Ödesjö et al., 2015), and medication reviews (Ödesjö et al., 2017), though not with intermediate outcomes connected to elderly or diabetics patient (Ödesjö et al., 2017, 2015). This similarity with the international evidence indicates that the lessons from Sweden may be of interest outside the study context.

A second contribution of the study is to extend the limited evidence base regarding P4P for hypertension treatments. This literature, which has focused exclusively on the US and UK, have found zero or temporary effects of P4P on hypertension-related process measures and intermediate or final health outcomes (Doran and Fullwood, 2007; Lee et al., 2011; Petersen et al., 2013; Serumaga et al., 2011; Simpson et al., 2011). A major weakness of this literature is that all studies except (Petersen et al., 2013) have been conducted in the UK, where all providers have become subject to P4P simultaneously and there is thus no control group. The decentralized healthcare system in Sweden allows for a stronger research design, as there are 21 independent county councils each designing its own reimbursement scheme to care providers. The influence of common confounding factors can therefore be eliminated in a difference-in-difference analysis, comparing providers in counties that introduced P4P to providers in counties that did not.

Institutional background

Primary care in Sweden

In Sweden, the mainly publicly financed health care system is organized by 21 county councils, which are independent and geographically defined governmental bodies. Although primary care has no formal gate-keeping function in Sweden, it is the first contact with care for most non-acute physical and mild mental health problems. In all county councils, primary care is mostly provided by group practices employing physicians, nurses and other staff categories such as physiotherapists and psychologists. Physicians operating solo practices are rare (Anell et al., 2012a). 29% of all (group) practices were private in 2006, a share that increased to 42% by 2013 due to the implementation of policies stimulating private entry in 2007-2010 (Dietrichson et al., 2016).

Each county council decides about its own reimbursement scheme for primary care providers. Capitation accounts for the largest part of reimbursement (60-80%), with visit fees making up most of the remaining part. P4P became a popular complementary (0-5% of revenues) reimbursement type during the past decade. In 2012, all but one county used at least one P4P measure in primary care (Anell, 2009; Anell et al., 2012b).

Drug costs are not covered by the reimbursement to care providers. In some county councils, providers have a separate drug budget that they have to balance. Elsewhere, the county council takes on the responsibility for drug costs (Granlund et al., 2006).

P4P for hypertension drug guideline compliance

The examined P4P incentives were intended to affect physicians' choice between two hypertension drugs: Angiotensin Converting Enzyme (ACE) inhibitors and Angiotensin Receptor Blockers (ARB). ACE and ARB are equally effective, but ACE is cheaper and therefore often recommended as first-line treatment, although it gives rise to a mild complication (cough) in a minority of patients (Godman et al., 2013).

Of the eight county councils that used P4P related to hypertension drug guidelines during the study period (Table 1), six used performance targets that were directly related to ACE's share of all ACE and ARB redemptions, with target levels around 75-80%. In the two other counties, the ACE share was incentivized indirectly, via an incentive for high compliance with all drug guidelines (i.e., not only hypertension). In all eight counties, target attainment was evaluated based on the performance of the health care practice as a whole, i.e., the P4P was a group incentive. The incentives were small, accounting for less than 1% of total revenues for an average health care practice.[1] Notably, as the general physicians (GPs) are reimbursed by a monthly salary, the P4P brought no direct monetary benefit to GPs that did not own their practices (or a share thereof).

- Table 1 about here -

[1] In the counties with indirect targets, the size of the ACE-related incentive is impossible to calculate, as it depends on how well providers complied with other guidelines.

Material and methods

Data

Data sources

The analysis uses yearly data for 2005-2013 from the Swedish Prescription Register (SPR), which covers all redemptions of drugs prescribed in outpatient care. The data is aggregated at the provider level – the unit of analysis – and includes information about the county council in which the provider is located and if it is private or public.

Information about county council-level policy variables were collected by a research assistant by reviews of official documents and correspondence with county council administrators. Data on the number of GP visits per inhabitants was collected from the Swedish Association of Local Authorities and Regions.

Because the study used aggregated data, the analysis did not require an ethical permission.

Sample

A first sample delimitation was to include only providers that had prescribed ACE and ARB each year they appeared in the register. Further exclusions were necessary because the SPR does not distinguish between prescriptions issued in primary vs. secondary outpatient care. To obtain a sample including mostly primary care providers, it was recognized that, compared to the more specialized clinics in secondary care, primary care providers treat a wide spectrum of conditions, reaching from respiratory tract infections to mild mental problems (Anell et al., 2012a). Thus, a provider was included in the estimation sample if it fulfilled the following inclusion criteria:

1. The provider had issued at least one prescription each of ACE and ARB every year it appeared in the register;
2. The provider had prescribed a broad range of substances, i.e., at least one antibiotics prescription (ATC code J01) and at least one prescription of nasal preparations (R01), cough medicine (R05) antidepressants (ATC N06AA) and/or hypnotics (N05C) during the years it appeared in the register.

2,202 providers fulfilled criterion 1 in 2010; of these, 1,220 also fulfilled criterion 2. This is only 10 providers short of the total number of primary care providers in 2010 according to existing registers of Swedish primary care providers (SPCP)(Dietrichson et al., 2016). Providers in the eight P4P counties accounted for 61% of all providers in the estimation sample, to be compared to 63% in the SPCP. The number of private providers was higher in the estimation sample (529 vs 470), which may due to misclassification but can also be explained by the under-coverage of private solo practices in SPCP. On balance though, the resulting estimation sample was deemed as reasonable. The Supplementary material to the paper includes a robustness check of our main model specification using an estimation sample defined by inclusion criterion 1 only.

Variables

The main outcome variable was ACE's share of all ACE and ARB redemptions, i.e. the number of ACE redemptions divided by the total number of ACE and ARB redemptions. The number of ACE and ARB redemptions were also analyzed separately.

Three county council-level variables were included as covariates: a dummy indicating counties where primary care providers had budget responsibility for prescribed drugs, a dummy indicating years after the choice and entry reforms, and the number of GP visits per 1,000 inhabitants in the county council.

Table 2 show definitions and summary statistics for the variables in the analysis.

-Table 2 about here -

Empirical strategy

A comparison of the ACE shares in P4P and non-P4P counties at a given point in time is unlikely to describe the effect of P4P, as their prescription cultures may differ for idiosyncratic reasons. Similarly, a simple before-after comparison of the outcomes within P4P counties would pick up not only the impact of P4P, but also the impact of all other simultaneous changes that affect the outcome variable. For instance, the first generic ARB was released during the study period (Godman et al., 2013). The implied change in relative prices may by itself have affected physicians' propensity to prescribe ARB or ACE.

By estimating a difference-in-differences (DID) regression model, it is possible to account for time-varying confounders like the introduction generic ARB, which affected the whole country at the same time; at least to the extent that the impact of such confounders is homogenous. In a DID regression, the change in the outcome variable before and after the introduction of P4P is compared with the change over the same time period in counties that never used P4P (Imbens and Wooldridge, 2009).

The difference in differences can be given a causal interpretation, under the assumption that the development of the outcome variable would have been the same if the P4P group had not changed their incentive scheme. It is not necessary that the treatment and control groups have a similar level of the outcome variable, as long as they follow the same trend (Imbens and Wooldridge, 2009). The trend assumption may be more or less plausible for the different P4P counties. To prevent obvious violations of the assumption, an initial graphical analysis was performed in which the development of the ACE share in each P4P county was compared to the development in the control counties (see the supplementary material). In three P4P counties (Skåne, Södermanland and Blekinge), the trends were judged to be too dissimilar from control counties. These counties were excluded from the further analysis.

Econometric specification

Equation 1 shows the baseline regression model:

$$y_{it} = \alpha + \beta_1 * HasP4P_{it} + \beta_2 * HasHadP4P_{it} + \mathbf{\beta_2} * \mathbf{X_{it}} + \boldsymbol{\gamma t} + \mu_i + \varepsilon_{it} \quad (1)$$

y_{it} is the outcome variable of municipality i at time t, α is a constant, $\mathbf{X}_{it}$ is a vector of time-varying covariates, $\boldsymbol{t}$ is a vector of calendar year dummies, μ_i is a provider-specific dummy (fixed effect, FE), and ε_{it} is an idiosyncratic error term. The provider FEs eliminate the influence of time-invariant unobserved heterogeneity. Notably, the provider FEs not only capture the influence of idiosyncratic features of each provider (e.g., organizational culture), but also of county-council-specific features that affect all providers in a given county similarly. The provider FE thus account for the multi-level nature of the data. The calendar year dummies capture year-specific shocks that had similar effects across the whole country (e.g., the introduction of generic ARB).

HasP4P is a dummy indicating providers that were subject to P4P in year *t*, while *HasHadP4P* is a dummy for providers that had been, but were no longer, subject to P4P (cf. Table 1). The parameters of interest capture the effect of being, or having been, subject to ACE-related P4P. Notably, in any given year, there is no within-county variation in $HasP4P_{it}$ *and* $HasP4P_{it}$, i.e., all providers in a given county are classified either as 0 or 1. For providers in the 13 control counties, these variables always equal to zero, whereas they vary over time for providers in the five analyzed P4P counties.

To analyze whether private and public providers differ in their response to P4P, the following equation was estimated:

$$y_{it} = \alpha + \boldsymbol{\beta_1} * \boldsymbol{P4P_{it}} + \beta_2 * Priv_{it} + \boldsymbol{\beta_3} * \boldsymbol{P4P_{it}} * Priv_{it} + \boldsymbol{\beta_4} * \mathbf{X_{it}} + \boldsymbol{\gamma t} + \mu_i + \varepsilon_{it} \quad (2)$$

Compared to Eq. 1, the specification in Eq. 2 includes interaction terms between each provider's ownership status (*Priv* = a dummy indicating privately owned providers) and $\boldsymbol{P4P_{it}}$, a vector including the variables *HasP4P* and *HasHadP4P*.

Standard errors were clustered at the county council level, as the P4P scheme was the same for all providers in a given county (Bertrand et al., 2004).

Sensitivity analyses

In addition to the graphical analysis, the similarity of the pre-P4P time trends were evaluated in the following model for 2005-2009:

$$y_{it} = \alpha + \gamma_1 t + \gamma_{12} * P4P * t + \mu_i + \varepsilon_{it} \quad (3)$$

In Eq. 3, t is a linear time trend and the potentially differential trend in P4P counties is captured by the interaction between t and a dummy (*P4P*) for providers in the counties that would later adopt P4P. A large and significant interaction term would indicate that the P4P counties followed a different trend already before they implemented P4P. Notably, of the five P4P counties included in the analysis, two introduced P4P before (Västernorrland, 2006) or in 2009 (Halland). Västernorrland was excluded from the estimations of Eq. 3, which was additionally estimated on a sample excluding observations from Halland and on a shorter sample period (2005-2008). As the parallel trends assumption could not be evaluated for Västernorrland, we also estimated an

alternative DID specification that allowed for differential linear time trends in P4P and control counties (Bell et al., 1999; Li et al., 2014):

$$y_{it} = \alpha + \beta_1 * HasP4P_{it} + \beta_2 * HasHadP4P_{it} + \boldsymbol{\beta_3} * \mathbf{X_{it}} + \gamma_1 t + \gamma_{12} * P4P * t + \mu_i + \varepsilon_{it} \quad (4)$$

The influence of specific counties on the main results were evaluated in leave-one-out analyses, in which the preferred model (Eq. 2) was repeatedly estimated, each time dropping the observations from one of the P4P counties. The sensitivity of the preferred model was also examined by removing the covariates, excluding providers with very few redemptions, excluding controls with comparably high ACE shares, clustering standard errors at the provider level (Cameron and Miller, 2015), and including providers fulfilling inclusion criteria 1 only.

Results

Although the P4P and control counties had different average ACE shares (50% vs 62% in the early period), Figure 1 shows that the development in the groups was similar until 2010, the year when generic ARB was introduced. For providers in the control counties, the ACE share decreased between 2009 and 2010. In the P4P counties, the ACE share did not start to decrease until the year thereafter.

- Figure 1 about here -
- Table 3 about here -

Table 3 shows the DID estimates of the P4P effect. Disregarding private/public ownership (column 1), the estimated effect of P4P on the ACE share was 3 percentage points ($p<0.01$), a 5% increase relative to the mean ACE share (56.4%). The interaction specification indicates that the P4P effect was significantly stronger for private providers (column 2). The changing ACE share of private providers reflects a substitution of ARB for ACE, while for public providers it was more a case of less growth of the ARB prescriptions (columns 3-5). For both provider types, the effect on the ACE share became insignificant once the incentive was removed.

The results of the sensitivity tests are available in the supplementary material. Notably, the pre-trend model does not reject the null hypothesis of parallel trends. The positive effect for private providers was robust to the sensitivity tests, while the effect for public

providers was less stable and appeared to be driven by the two largest counties (Västra Götaland and Stockholm), in which the incentive was indirect. Notably, the positive effect on private providers remained when excluding one P4P county at a time from the analysis, which is interesting given that the targets and incentive sizes differed across counties. The results were also similar when providers that failed to meet inclusion criterion 2 were included in the sample, although the public-private interaction was attenuated. The attenuation was expected, given that the more comprehensive sample included a large number of providers that were not subject to P4P (i.e., outpatient secondary care clinics (Anell, 2015)).

Discussion

On balance, the results strongly suggest that the private providers reacted to P4P, while public providers reacted only in a few counties. The findings are consistent with the idea that monetary incentives are of higher importance for profit-maximizing providers, and also with the idea that individuals attracted to the private sector are relatively more motivated by extrinsic rewards (Georgellis et al., 2011). At the same time, it seems to rule out that public providers are completely insensitive to P4P; rather, the results indicate that their reaction depend on the circumstances.

The ACE share was lower for providers in the P4P counties than for providers in the control counties, which suggests that the decision to implement the P4P policy was driven by policy-makers wanting to approach the levels of other counties. While such selectivity in the decision to adopt P4P may limit the generalizability of the findings, it is not clear in what direction the bias would go. On the one hand, it may be easier to increase the ACE share if it initially is low. On the other hand, providers in the P4P counties may have firmly grounded aversion towards ACE, making it harder to influence their prescribing decisions. Notably, because policies like this are rarely randomized, a treatment-on-the-treated effect like the one estimated here is a relevant policy parameter.

Many of the counties using P4P for the ACE share chose to remove the indicator after a few years. One obvious reason may be that the introduction of generic ARB made the issue less important. Previous research suggests that there are many reasons why counties often choose to replace their P4P indicators: satisfaction or disappointment with achieved outcomes, experiences that the performance measure is too volatile at the health

care unit level, or simply a desire to prioritize something new (Ellegård et al., 2018; Johansson Krafve, 2015). In Sweden, there has also been a growing critique against the use of monetary incentives in the health care sector (SOU, 2017).

The analysis has several limitations. As already discussed, it was necessary to make assumptions about which providers in the prescription registers that were primary care providers. It is thus possible that some providers were misclassified, although the sensitivity analysis indicated that the consequences of the sample delimitation were small.

Another weakness of the study is that the register does not include prescriptions that were not redeemed by the patient. Notably though, unless patients' redemption decisions have changed differentially over time in P4P and non-P4P counties, the difference-in-differences analysis accounts for systematic differences between P4P and non-P4P counties.

A remaining caveat is that the empirical strategy only accounts for changes over time that affected providers in all county councils similarly. For instance, if the introduction of generic ARB had different impact in different counties, the estimated "P4P" effect also includes the differential effect of price changes. By controlling for the drug budget responsibility in each county, the model to some extent mitigates this concern, though.

The observational study setting implies some complications. Almost all county councils experimented with different P4P indicators during the study period, and it is not possible to rule out that the effect to some degree reflects that the ACE share received *less* attention by providers in counties that just had adopted incentives for other, unrelated goals (Holmström and Milgrom, 1991). In one of the P4P counties (SLL), the total number of patients prescribed ACE or ARB was also incentivized, meaning that the impact in that county might reflect a changing patient mix. Notably though, the result that private providers react to P4P was unchanged even when providers from SLL was left out of the analysis.

Notwithstanding the limitations of the study, it is interesting to note that the estimated effect of 5% was similar in magnitude to the typical estimate for process measures found in previous P4P studies (Herck et al., 2010; Ogundeji et al., 2016). The estimate was also similar in magnitude to that of a previous Swedish study that concerned incentive for

compliance with antibiotics guidelines (Ellegård et al., 2018) and qualitatively similar to other findings from Sweden (Ödesjö et al., 2017, 2015). In difference to previous evidence from Sweden, (Ellegård et al., 2018), but similar to findings in other contexts (Constantinou et al., 2017), the effect only lasted as long as the incentive was in place.

Of studies on P4P for hypertension-related performance measures, this is the first to consider the ACE share. Observational time-series studies from England and Scotland found no trend breaks around the time of P4P implementation with respect to the number of prescribed hypertension drugs or recordings of blood pressure (Lee et al., 2011; Serumaga et al., 2011; Simpson et al., 2011). A randomized control trial in the US found a temporarily increase in the percentage of patients on recommended drugs when incentives targeted individual physicians, but no effect of group incentives (Petersen et al., 2013). It has been argued that the target levels in the English P4P scheme were too low to spur further improvements (Serumaga et al., 2011); by contrast, the typical target levels in Sweden (Table 1) ought to have presented a challenge for the Swedish care providers. In relation to the results from the US study, it is interesting that the Swedish incentives appear to have been effective despite that they were directed to the health center rather than to individual physicians. However, given the vast differences in terms of institutional settings and study designs, it is difficult to pinpoint the reasons why the results differ.

Conclusions

P4P increased compliance with first-line drug treatment guidelines for hypertension in Sweden. The effect was particularly strong for private providers, while the effect on public providers was present only in a few counties. Future research should seek to investigate the conditions under which public providers do react to monetary incentives. Policymakers and researchers ought to acknowledge that the different underlying incentive structures of public and private providers may modulate the effectiveness of P4P, even when little money is at stake.

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Figures

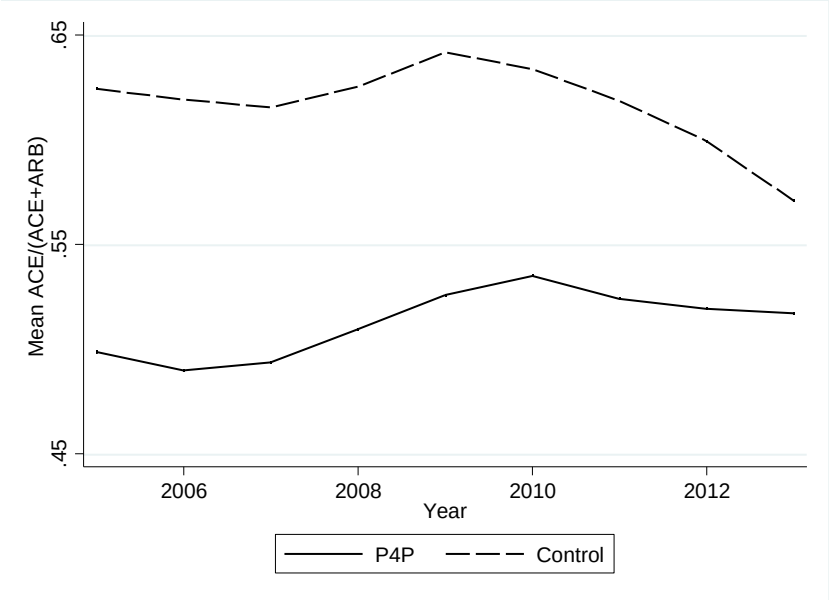


Figure 1. ACE share by year and P4P status.

Note: Yearly average ACE share, calculated separately for two groups of counties: those that used P4P at some point in time (P4P) and those that never did (Control). Providers from Skåne, Södermanland and Blekinge are excluded. Within the P4P group, the identity and number of counties actually using P4P varied over the time period (see Table 1).

Tables

Table 1. Counties using P4P for ACE/ARB during study period

County	Years	Direct (D)/Indirect (I)[b]	Target [c]
Västernorrland (VN)	2006-2009	D	2 levels: 62/73%
Skåne[a]	2009-2011	D	80%
Halland (HN)	2009-2012	D	80%
Södermanland[a]	2010-2011	D	80%
Örebro (OB)	2010-2012	D	2 levels: 76/86%
Stockholm (SLL)	2010-2013	I	80%
Västra Götaland (VG)	2010-2013	I	49-55%
Blekinge[a]	2012	D	70%

Source: Anell 2009; Anell, Nylinder, and Glenngård 2012; county councils' accreditation documents and personal communication. Information is available for 2005-2013.

[a] Excluded from main analysis.

[b] *Direct* means that the P4P target was explicitly related to the ACE share. *Indirect* means that the P4P target referred to the guideline compliance rate for *all* prescribed drugs (not only hypertension drugs).

[c] In counties with Direct targets, the target level refers to the ACE share. In counties with Indirect targets, the target level refers to the total guideline compliance rate for all drugs.

Table 2. Summary statistics and variable definitions

Panel A: Summary statistics

	2006				2013			
	Control		P4P		Control		Ever P4P	
	mean	sd	mean	sd	mean	sd	mean	sd
ACE share	0.62	0.18	0.49	0.21	0.57	0.17	0.52	0.19
ACE	1,058	1,089	514	799	1,190	1,538	763	1,127
ARB	562	629	428	543	817	1,066	618	843
PrivOwn	0.31	0.46	0.52	0.5	0.32	0.47	0.5	0.5
DrugBudget	0.47	0.5	0.28	0.45	0.94	0.23	0.3	0.46
GPvisits	1,294	114	1,543	154	1,345	153	1,757	309
ChoiceReform	0	0	0	0	1	0	1	0
N.o. providers	427		463		482		498	

Panel B: Variable definitions

Variable	Definition	Aggregation level	Type
ACE share	Number of ACE redemptions/(number of ACE and ARB redemptions)	Provider (P)	Dependent variable (main)
ACE	Number of ACE redemptions	Provider	Dependent variable
ARB	Number of ARB redemptions	Provider	Dependent variable
PrivOwn	PrivOwn=1 if privately owned PrivOwn=0 if publicly owned or unknown ownership	Provider	Interaction variable
DrugBudget	=1 if each care provider has responsibility for its own drug budget =0 if care providers are not responsible for costs of prescribed drugs	County council (C)	Covariate
GPvisits	Number of GP visits per 1,000 inhabitants	C	Covariate
ChoiceReform	Dummy for years after implementation of patient choice and free entry in primary care	C	Covariate

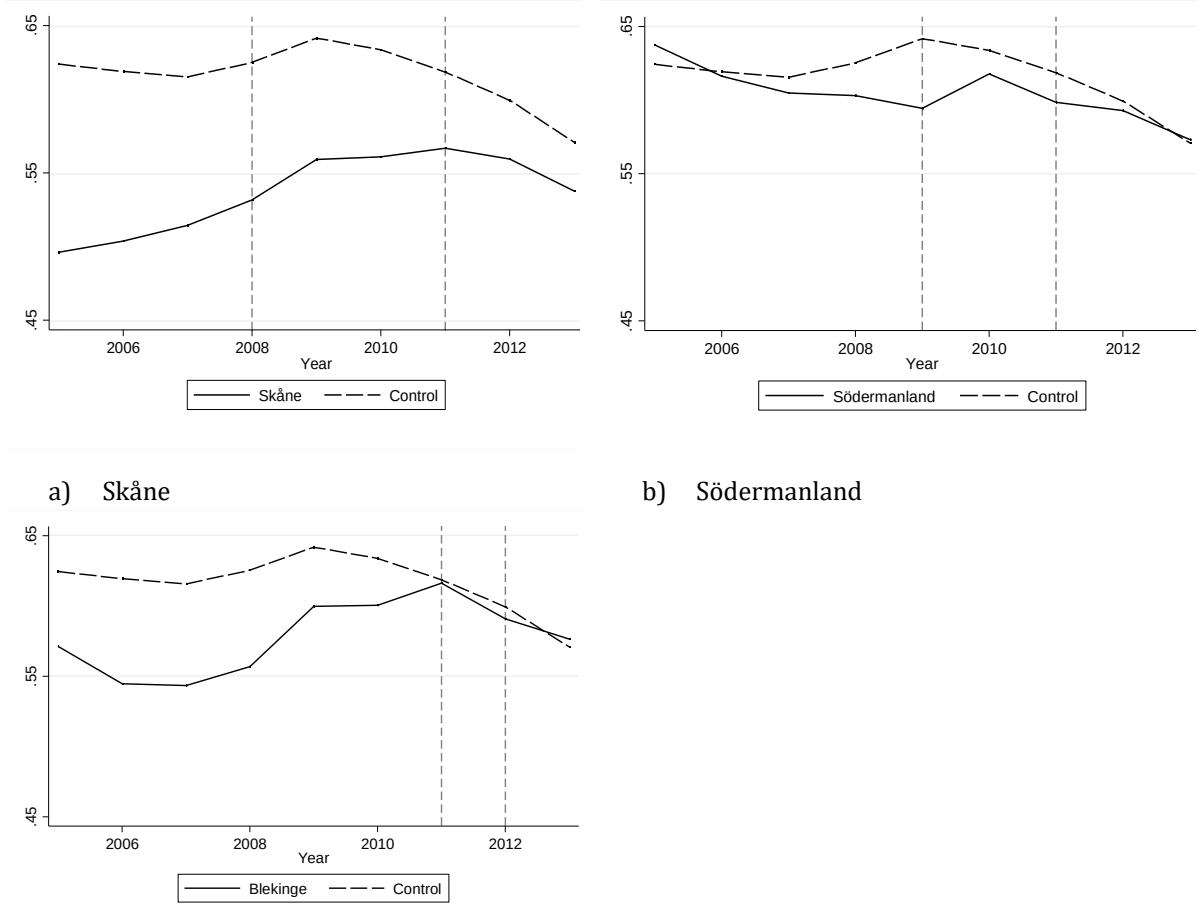
Table 3 Main results

	(1)	(2)	(3)	(4)	(5)
Dependent variable (y):	ACE share	ACE share	ACE	ARB	ACE+ARB
HasP4P	0.0299***	0.0184**	151.2	44.58	195.8
	(0.00614)	(0.00753)	(139.4)	(88.49)	(226.0)
PrivOwn		-0.00241	5.088	11.93	17.01
		(0.00658)	(58.09)	(38.42)	(93.84)
HasP4PxPrivOwn		0.0228**	-254.3*	-188.5**	-442.7**
		(0.00843)	(124.1)	(79.76)	(203.6)
HasHadP4P	0.0194	0.00458	278.9*	136.7*	415.6*
	(0.0149)	(0.0124)	(141.8)	(77.17)	(215.3)
HasHadP4PxPrivOwn		0.0337	-122.8	-40.96	-163.7
		(0.0306)	(87.96)	(97.93)	(168.3)
DrugBudget	0.0129	0.0133	250.4**	114.3*	364.7**
	(0.00869)	(0.00863)	(108.6)	(60.09)	(164.9)
GPvisits	3.98e-05	3.67e-05	0.0904	0.0977	0.188
	(2.60e-05)	(2.47e-05)	(0.268)	(0.164)	(0.416)
choicereform	-0.0127**	-0.0125**	-77.16*	-26.91	-104.1*
	(0.00489)	(0.00484)	(38.93)	(20.96)	(57.69)
Constant	0.502***	0.507***	85.45	12.04	97.49
	(0.0340)	(0.0327)	(374.3)	(222.9)	(570.8)
Observations	8,581	8,581	8,581	8,581	8,581
R-squared	0.030	0.032	0.197	0.207	0.210
Number of providers	1,029	1,029	1,029	1,029	1,029
Counties	18	18	18	18	18
Mean of y	0.564	0.564	902.2	579.5	1,482
HasP4P = HasHadP4P (p)	0.477	0.253	0.129	0.0761	0.101
ME HasP4PxPriv (p)		0.000	0.292	0.0146	0.109
ME HasHadP4PxPriv (p)		0.218	0.241	0.338	0.200

Estimates of Eq. 1 (column 1) and Eq. 2 (column 2-5) using the following dependent variables (y): *ACE share* = ACE's share of all ACE and ARB redemptions in columns 1-2, *ACE* (*ARB*) = n.o. ACE (ARB) redemptions in column 3 (4), *ACE+ARB* = total n.o. ACE and ARB redemptions in column 5.
HasP4P = HasHadP4P (p) = p-value of test of equality of coefficients. ME HasP4PxPriv (p) = p-value of test of marginal effect of P4P for private providers. ME HasHadP4PxPriv (p) = p-value of test of marginal effect of previously having had P4P for private providers.
Robust standard errors clustered by county in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Supplementary material

Development of the ACE share in the excluded counties



a) Skåne

b) Södermanland

c) Blekinge

Fig S1. ACE share by year. Skåne, Södermanland and Blekinge vs. control group
The two dashed lines mark the last year before P4P was implemented and the last year P4P was in place, respectively. Skåne, Södermanland and Blekinge are not included in the main estimations.

Sensitivity tests

Table S1 shows the pre-trend tests (Eq. 3 in main text). Providers from Västernorrland (VN), where P4P was introduced in 2006, are excluded from all estimations. Eq. 3 was estimated first without providers in Halland, where P4P was introduced in 2009 (column 1), and then including these providers (column 2) and excluding 2009 (column 3). The coefficients on the interaction between being a P4P county and the linear trend variables are insignificant, suggesting that the parallel trends assumption is not violated.

Table S1. Pre-trend test of parallel trends

	(1)	(2)	(3)
Variable	ACE share	ACE share	ACE share
time	0.00332**	0.00329**	2.13e-05
	(0.00140)	(0.00141)	(0.00177)
TreatTrend	0.00382	0.00431	0.00551
	(0.00430)	(0.00400)	(0.00484)
DrugBudget	0.0154**	0.0153**	0.0105
	(0.00555)	(0.00550)	(0.00685)
GPvisits	-2.62e-05	-3.15e-05	-5.94e-05
	(5.54e-05)	(5.49e-05)	(6.31e-05)
choicereform	-0.00350	-0.00223	-0.00151
	(0.00882)	(0.00829)	(0.0108)
Constant	0.580***	0.589***	0.633***
	(0.0771)	(0.0770)	(0.0888)
Observations	4,363	4,511	3,549
R-squared	0.009	0.010	0.002
Number of providers	938	969	944
Counties	16	17	17
Halland	No	Yes	Yes
Västernorrland	No	No	No
Years	2005-2009	2005-2009	2005-2008

Cluster-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. time is a linear time trend variables and TreatTrend is the interaction between *time* and a dummy for P4P counties.

Table S2 shows the results of the preferred model (Eq. 2, col 1) and the leave-one-out specifications (col. 2-7). The results for the key variables *HasP4P* and *HasP4PxPriv* are stable unless SLL or VGR is excluded, in which case the effect for public providers disappears while the effect on private provider is enforced. The variables indicating previous experience with P4P (HasHadP4P) are more unstable, but were also imprecisely estimated in the preferred model.

Table S2. Leave-one-out estimates of the ACE share

Excluded county:	(1) N/A	(2) VN	(3) HN	(4) OB	(5) SLL	(6) VGR	(7) SLLVG
HasP4P	0.018	0.021	0.021	0.023	0.01	0.014	-0.01
	0.008	0.008	0.007	0.006	0.012	0.008	0.004
Priv	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001
	0.007	0.007	0.007	0.007	0.009	0.007	0.009
HasP4Px Priv	0.023	0.021	0.021	0.019	0.038	0.021	0.052
	0.008	0.008	0.008	0.007	0.009	0.01	0.003
HasHad P4P	0.005	-0.003	0.013	0.004	0.002	0.005	-0.007
	0.012	0.017	0.01	0.014	0.013	0.012	0.013
HasHad P4PxPriv	0.034	0.065	0.03	-0.002	0.045	0.034	0.056
	0.031	0.008	0.04	0.032	0.029	0.031	0.024
Constant	0.507	0.51	0.506	0.52	0.54	0.498	0.582
	0.033	0.037	0.035	0.035	0.038	0.033	0.039
Observations	8,581	8,361	8,310	8,149	6,306	7,380	5,105

Column 1 shows the preferred model specification, in which 5 P4P counties are included. In columns 2-7, observations from one P4P county council at a time are excluded. VN=Västernorrland, HN=Halland, OB=Örebro, SLL=Stockholm, VGR=Västra Götaland. In column 7, both SLL and VG are excluded. The table shows coefficients and standard errors.

Table S3 shows the preferred model (column 1) along with various sensitivity tests. Column 2 shows the differential trends specification (Eq. 4), in which the P4P effect disappears for public providers but remains (although it is slightly attenuated) for private providers. Note that the significant interaction term TreatTrend does not imply a violation of the parallel trends assumption, as the trend is extended over the whole sample period in this specification. Column 3 shows that the county level covariates are not influential for the result of the preferred model. In column 4, providers for which there were fewer than 98 redemptions of ACE and ARB (combined) are excluded from the estimation (98 is the lowest quartile of the distribution of ACE+ARB redemptions). This sample restriction mostly serves to increase the P4P effect for public providers; the total marginal effect on private providers is practically unchanged. In column 5, observations in the control group whose ACE share is higher than 70% are excluded, to check if the results are driven by the generally lower ACE-shares in P4P counties. This appears to be true to some degree, as the effect for public providers disappears (*HasP4P* becomes smaller and insignificant), while the P4P effect is attenuated (though still strongly significant) for private providers. In column 6, standard errors are clustered at the provider level instead of the county level (Cameron and Miller 2015). The county level s.e. are sometimes, but not consistently, smaller, but the difference is always very small, suggesting that the small number of clusters is not a problem in this case. Finally, in column 7 we relax the second sample inclusion criterion, i.e. all providers that prescribed both ACE and ARB every year in the sample are included in the analysis. As explained in subsection *Sample*, this means that the sample includes providers not from primary care (who were not affected by the P4P scheme), but on the other hand there is also a risk that inclusion criterion 2 misclassified some primary care providers as secondary care and vice versa. As expected, given that P4P was not used in secondary outpatient care, the estimates are attenuated with the less restrictive sample, though the results clearly go in the same direction. The difference between public and private is not significant, though the total marginal effect is still 40% greater for private providers (0.00638/0.0168) and close to the 10% significance level. Further estimations (not shown) show that the positive effect on private primary care providers remain for the more comprehensive sample also if SLL and VG are excluded.

Table S3. Sensitivity of preferred model of ACE share (Eq. 2)

Variable	(1) Preferred	(2) Differential trends	(3) No covars	(4) Excl low-prescribers	(5) Excl high ACE-share controls	(6) Provider-cluster s.e.	(7) Incl criterion 1
HasP4P	0.0184**	-0.000757	0.0194*	0.0265***	0.00789	0.0184**	0.0168***
	(0.00753)	(0.00929)	(0.00958)	(0.00435)	(0.00716)	(0.00758)	(0.00548)
PrivOwn	-0.00241	-0.00186	-0.00218	-6.90e-05	-0.00130	-0.00241	0.00485
	(0.00658)	(0.00681)	(0.00643)	(0.00747)	(0.00471)	(0.00820)	(0.00591)
HasP4PxPrivOwn	0.0228**	0.0212**	0.0230**	0.0164***	0.0224**	0.0228**	0.00638
	(0.00843)	(0.00784)	(0.00857)	(0.00332)	(0.00826)	(0.0101)	(0.00386)
HasHadP4P	0.00458	-0.0421**	0.00248	0.0251***	-0.0141	0.00458	0.00117
	(0.0124)	(0.0182)	(0.0135)	(0.00738)	(0.0108)	(0.0149)	(0.0113)
HasHadP4Px PrivOwn	0.0337	0.0318	0.0336	-0.00156	0.0349	0.0337	0.00304
	(0.0306)	(0.0317)	(0.0305)	(0.0242)	(0.0305)	(0.0225)	(0.0146)
time		-0.00670***					
		(0.00183)					
TreatTrend		0.00641**					
		(0.00260)					
DrugBudget	0.0133	0.0251***		0.00732	0.0102	0.0133**	0.0115
	(0.00863)	(0.00824)		(0.00692)	(0.0101)	(0.00667)	(0.00888)
GPvisits	3.67e-05	2.98e-05		3.02e-05	2.04e-05	3.67e-05	2.98e-05*
	(2.47e-05)	(2.37e-05)		(1.82e-05)	(2.45e-05)	(2.63e-05)	(1.65e-05)
choicereform	-0.0125**	0.000748		-0.00253	-0.0110*	-0.0125**	-0.00868
	(0.00484)	(0.00546)		(0.00288)	(0.00552)	(0.00580)	(0.00502)
Constant	0.507***	0.519***	0.564***	0.530***	0.485***	0.507***	0.521***
	(0.0327)	(0.0342)	(0.00531)	(0.0241)	(0.0335)	(0.0378)	(0.0218)
Observations	8,581	8,581	8,581	6,433	7,205	8,581	15,804
R-squared	0.032	0.018	0.031	0.071	0.027	0.032	0.021
Number of providers	1,029	1,029	1,029	877	991	1,029	1,927
Counties	18	18	18	18	18	18	18
Mean y	0.564	0.564	0.564	0.564	0.564	0.564	0.564
HasP4P = HasHadP4P (p)	0.253	0.00425	0.107	0.819	0.0635	0.295	0.121
ME HasP4PxPriv (p)	1.05e-05	0.00479	2.46e-06	2.51e-10	6.23e-05	4.61e-06	0.000390
ME HasHadP4PxPriv (p)	0.218	0.741	0.213	0.299	0.512	0.0460	0.852

Cluster-robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variable = ACE share. ME HasP4PxPriv (p) = p-values of test of marginal effect of P4P for private providers. ME HasHadP4PxPriv (p) = p-values of test of marginal effect of previously having had P4P for private providers. time is a linear time trend variables and TreatTrend is the interaction between *time* and a dummy for P4P counties.