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Substituting emergency services: primary care vs. hospital care

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ABSTRACT

Overcrowding in emergency departments (EDs) is inefficient, especially if it is caused by inappropriate visits for which primary care physicians could be equally effective as a hospital ED. Our paper investigates the extent to which both ambulatory ED visits and inpatient ED admissions are substitutes for primary care emergency services (PCES) in Germany. We use extensive longitudinal data and fixed effects models. Moreover, we add interaction terms to investigate the influence of various determinants on the strength of the substitution. Our results show significant substitution between PCES and ambulatory ED visits. Regarding the determinants, we find the largest substitution for younger patients. The more accessible the hospital ED is, the significantly larger the substitution. Moreover, substitution is larger among better-educated patients. For inpatient ED admission, we find significant substitution that is eight times smaller than the substitution for ambulatory ED visits. With regard to the determinants, we find the strongest substitution for non-urgent, short-stay admission and elderly patients. Countries with no gate-keeping system (such as Germany) have difficulties redirecting the patients streaming to EDs. Our estimated elasticities can help policy makers to resolve this issue, as our findings indicate where incentivizing the utilization of PCES is particularly effective.

1. Introduction

1.1. Background

The growing use of emergency departments (EDs), or even overcrowding, in the US, UK, Germany, Canada, Australia, New Zealand, Ireland, and other nations has become a leading target of health care reforms [1–5]. Overcrowding in EDs is inefficient, especially if it is caused by inappropriate visits for which primary care physicians could be equally effective as a hospital ED. Overcrowding increases pressure on hospital resources, results in the inefficient allocation of resources and reduces the capacity to provide care to critically ill patients in a timely manner [4,6,7]. For example, studies suggest that at least 30% of all ED visits in the US are non-urgent [8]. Furthermore, the number of admissions from EDs to hospital has grown substantially in, for instance, the UK, the US, and Germany. Accordingly, a certain proportion of these admissions is suspected to not necessarily require inpatient emergency care [5,9,10] and could even be avoided by using primary care. In any case, reducing ED admissions is a popular strategy for reducing healthcare expenditures [11,12]. For example, the NHS introduced the "marginal rate rule" in 2010 in response to growth in the volume of patients being admitted to hospital as emergencies. This rule sets a baseline value for income from each provider's emergency admissions. For emergency admissions above this baseline, the provider receives only 30% of the normal price [13,14]. We investigate the extent to which the utilization of emergency services in the primary care sector affects the utilization of hospital EDs and hospitalizations from EDs in Germany.

1.2. Institutional context

Patients in Germany have unlimited access to the health care system. In contrast to other European countries, Germany has no formal gate-keeping system. Patients seeking urgent care during off hours (i.e., at night or on weekends, which account for over 70% of the hours in a week) can either visit the primary care emergency service (PCES) for urgent non-life-threatening conditions or self-refer to a hospital ED (which provide service around the clock) for urgent life-threatening conditions and receive ambulatory or inpatient treatment. The PCES has to be organized by each regional association of statutory health insurance (SHI)-accredited physicians to ensure access to primary care around the clock. SHI-accredited physicians are obliged to provide out-of-hours care according to a duty schedule. SHI payments for PCES and ambu-

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latory ED treatment are based on the same fee schedules, whereas inpatient admissions are reimbursed via DRGs. The SHI provides full coverage of all services even if patients with non-life-threatening conditions visit hospital EDs, regardless of which service is used. Therefore, part of the patients uses EDs for all kinds of conditions, which leads to ED crowding. Thus, it is often argued that policy makers should incentivize patients to use PCES instead of EDs.

Whether policymakers should encourage increases in PCES utilization to reduce ED visits depends, among other things, on the elasticity of the number of visits to PCES with respect to the number of visits to EDs, i.e., on the potential to substitute. There are several considerations from a theoretical standpoint: PCES and ED visits could be substitutes, as the patient has free choice in utilization. In a substitutional relationship, the treatment can be carried out in either sector. Alternatively, physician referral might be an important driving force in ED attendance [8]. In that case, a PCES visit complements an ED visit; i.e., the patient uses services in both sectors. As they represent different types of care, utilization of the sectors could also be unrelated. According to previous evidence, we hypothesize that the predominant relationship is substitutional (i.e., the elasticity is negative and substantial). Consequently, incentivizing an increasing use of PCES could have a significant, positive externality on ED crowding.

1.3. Related literature

There is an extensive literature on the reasons for the increased crowding in EDs, e.g., Uscher-Pines et al. [8]'s review of ED visits for non-urgent conditions. Directly relevant to our context, a number of survey studies investigate the reasons that patients used EDs instead of (out-of-hours) primary care services, e.g., Rajpar et al. [15]. The main reasons identified were easier accessibility of the ED, the convenience and availability of any tests or X-rays, a lack of knowledge about the availability of PCES, and self-perceived urgency of the condition. The largest group to present to EDs with primary care problems were young adults.

The empirical health economics literature is rather scarce. Kopetsch and Schmitz [16] find a general substitutional relationship between ambulatory services and hospitalizations in the German market. Some studies investigate the effect of the extension of the usual primary care opening hours on ED utilization. These studies are limited to several practices, single hospitals or regional areas. In the US, Lowe et al. [17] find that Medicaid patients use EDs up to 20% less if GP practices are open during the evening hours. Thompson et al. [18] investigate the impact of a change in the GP contract in the UK that reduced out-of-hours access to GPs. They find a significant increase in patients with non-traumatic conditions presenting to the ED outside of office hours, whereas the number of patients presenting with traumatic conditions remained unchanged [18]. Dolton and Pathania [19] analyse the effect of a pilot project to improve primary care access with GP practices being open seven days per week. Their study employs a difference-in-differences analysis based on 34 practices (four with seven-day opening hours and 30 without seven-day opening hours) in central London. They find that seven-day GP opening hours reduced ambulatory ED visits on weekends by 17.9% and a 10% reduction in ED admissions over the weekend. Bruni et al. [6] claim that GPs in one Italian region who extended their operating hours to 12 h per day could reduce inappropriate ED visits by 10–15% [6].

1.4. Contribution

Our paper contributes to the literature on patient use of EDs instead of primary care. We examine the extent to which both ambulatory ED visits and inpatient ED admissions are substitutes for PCES (i.e., the degree of substitution between primary care and secondary care, as well as tertiary care emergency services). Understanding this relationship allows us to determine the degree to which increased use of PCES can mitigate ED crowding and reveal costly spillovers to potentially inappropriate inpatient care. To the best of our knowledge, we are the first to empirically investigate that relationship by leveraging a detailed and novel longitudinal dataset, which captures the vast majority of the market for emergency care. Previous studies rely on survey data, case studies or regionally limited settings. Moreover, we are able to empirically assess the influence of several driving factors on the strength of the substitution, which were identified in previous (survey) research. Thus, our estimations yield elasticities that depict the substitutional potential for various settings and subgroups. An important novelty of our study is that we can differentiate urgency levels for inpatient ED admissions on individual level, whereas previous research was unable to distinguish urgent from non-urgent inpatient ED admissions. That closer examination is particularly worthwhile since a substitution of PCES visits in favour of inpatient admissions entails reimbursement via DRG, which is at least an order of magnitude higher.

2. Data

We used a variety of data sources to construct an age group, gender and county-specific dataset during the period from 2010 to 2014. Our most important source is utilization data from the National Association of Statutory Health Insurance Physicians. This dataset contains the numbers of ambulatory cases for the years 2010–2014 for both emergency services delivered by the PCES physicians and hospital EDs. The dataset includes all persons insured under SHI and thus covers 90% of the population. We use a separate dataset collected through administrative reimbursement data that covers inpatient short-stay ED admissions in Germany from 2010 to 2013. Population data for all age group and gender combinations in each county were gathered from the Federal Statistical Office. To best describe the substitution, all data refer to the patients' place of residence and not to where they were treated. Persons older than 99 years were excluded. Additional explanatory variables were obtained from the INKAR database of the Federal Office for Building and Regional Planning, which contains indicators based almost exclusively on official statistics. To create homogenous and comparable observational units over time, we related all of the data sources to German counties in the 2011 version. Our data cover approximately 75% of the entire German market; data on seven federal states were unavailable (Schleswig-Holstein, Hamburg, Bremen, Hessen, Rheinland-Pfalz, Berlin, Thüringen). Table A1 reports the descriptive statistics for all variables, and Table A2 reports the total number of cases for the three treatment options over time (see Online Appendix). The aggregate number of cases in the PCES changes little over time; however both ambulatory ED visits and inpatient admissions cases show tremendous growth rates.

3. Methods

The general objective of our models is to obtain unbiased estimations of the substitutional relationships. To link all of our data sources, we aggregated our variables into demographic groups based on age group, gender and county in a synthetic panel (see, for example, [20,21]). We included ten-year age groups for men and women in the 298 counties, for a total of 5607 observations made from 2010 to 2014 for ambulatory treatments and 5891 observations made every year over the period 2010–2013 for inpatient admissions. Preliminary investigation suggested using a specification in which both the dependent and explanatory variables are

measured in logs. We used a fixed-effects model to control for potential omitted variables. Annual fixed effects allow us to separate the effect of PCES utilization on ED utilization from time trends associated with omitted factors, such as changes in morbidity or technological progress. We also controlled for unobserved heterogeneity for each combination of age group, gender and county.

Our baseline regression Model (1) is

$$ED_{it} = \beta_1 PCES_{it} + \beta_2 X'_{ct} + \beta_3 P_{it} + \delta_i + \alpha_t + u_{it} \quad (1)$$

where ED_{it} is the number of ED visits (either ambulatory treatments or inpatient admissions) and $PCES_{it}$ is the number cases in PCES at level i(age group, gender and county) in year t. X'_{ct} is a vector of supply-side control variables in county c and year t. We use the number of hospital beds per 10,000 inhabitants, the number of PC physicians and PC paediatricians per 100,000 inhabitants. P_{it} is the population size, which is included to disentangle potential substitution from uniform changes in both ED and PCES cases as a response to changes in the population. δ_i are fixed effects at level i and α_t are annual fixed effects. All observations are frequency-weighted by the underlying population size, and the standard errors are clustered at the age group, gender and county level. To investigate the determinants of the substitution, we subsequently add categorical variables D_{ct} for county c and year t to Model (1) and build their interaction terms (two-way or three-way) with PCES (Model (2)). The Categories rely on percentiles of corresponding measures. The coefficients on the interaction terms provide us with the relative effects (i.e., relative strength) of the substitution.

$$ED_{it} = \beta_1 PCES_{it} + \beta_2 D_{ct} * PCES_{it} + \beta_3 D_{ct} + \beta_4 X'_{ct} + \beta_5 P_{it} + \delta_i + \alpha_t + u_{it} \quad (2)$$

Though our FE identification strategy accounts for numerous sources of potential bias, we still face possible endogeneity. Whereas reversed causality is less of a concern when investigating substitution, which works in both directions, unobserved time-varying heterogeneity might influence our results.

Regarding the substitution for ambulatory treatments in the ED, the driving factors we investigate are age, the accessibility of PCES practice and hospital ED, and education. To incorporate ED accessibility, we use average hospital distance, measured in driving minutes, at the county level. We use SHI-accredited GP density at the county level as a proxy for PCES practice accessibility. As a proxy for education, we use the proportion of academics in the working population. For that analysis, we are limited to a subset, as education data are only available from 2012 to 2014.

Regarding the substitution for ED admissions, we confine our analysis to inpatient treatments for a short stay (length of stay <= 1, 2 or 3 days). We do not expect any substitutional potential between PCES and ED admissions that required a longer inpatient stay. We investigate the strength of the substitution with respect to age and the urgency of inpatient admissions. To do so, we exploit the results of Kramer et al. [22]. These authors use supervised machine learning methods to classify inpatient admissions in elective and emergency care and assign urgency degrees between 0% and 100% to every relevant primary diagnosis in the ICD catalogue [22]. Thus, we match these urgency degrees to our inpatient admissions data on the level of individual primary diagnoses. We stratify our dependent variable into four degrees of urgency (ED_{iut}): (non-urgent (0–25%), e.g., chronic tonsillitis, low urgency (25–50%), e.g., pain localized to the upper abdomen, urgent (50–75%), e.g., congestive heart failure, and high urgency (75–100%), e.g., syncope and collapse).

4. Results

Table 1 reports estimation results for ambulatory ED visits, and Table 2 reports the results for inpatient ED admissions. Column 1 presents the fixed-effect regression results for the baseline Model (1). The other columns show variants of Model (2) for various determinants of the substitution. We report these coefficients as marginal effects (i.e., elasticities) for ease of interpretation. All models reported in Tables 1 and 2 pass the Hausman test, thus supporting the use of a fixed- rather than a random-effects specification.

4.1. PCES and ambulatory ED visits

Our baseline model in Table 1 (Column 1) yields an elasticity of ED visits with respect to PCES cases of 0.25. Thus, a 10% increase in PCES cases is associated with a decrease of ambulatory ED visits by 2.5%. Regarding other covariates, the supply of hospital beds, PC physicians and PC paediatricians at the county level appear insignificant but change little during the five-year period. In contrast, annual fixed effects indicate large unobserved factors that influence ED cases. The increase in cases due to unobservable factors between 2010 and 2014 is 32.4%.

Figs. 1 and 2 show the percentage change in ED cases on the y-axis (ambulatory visits or inpatient admissions) which is associated with a one per cent increase in PCES cases. Fig. 1a depicts the strength of the substitution by age estimated in Model (2) (Table 1 Column 2). The largest substitution is found between 10 and 49 years. From the age of 50, substitution decreases steadily. Whereas a 10% increase in PCES cases relates to a reduction of ambulatory ED visits by 3.0% for 20–29-year-olds, visits for individuals over 90 years old only relate to a reduction by 1.5%.

Table 1, Column 3 shows the substitution interacted with three strata of ED accessibility. Column 4 shows the substitution for strata of PCES accessibility, and in Column 5, we use a three-way interaction of substitution with both accessibilities. There is clear evidence of a differential impact. The more accessible the hospital ED is, the significantly higher the substitutional potential. The more accessible a PCES practice is, the significantly lower the substitutional potential. The marginal effects (Table 1, Column 5) in Fig. 1b show that ED distance plays more of a role in determining the substitution. The strongest increase in ED visits related to substitution is where the PCES practice is distant and a hospital ED is nearby (if PCES decreases by 10%, ED increases by 3.8%). If ED accessibility is poor and PCES accessibility is good, we do not find any significant substitutional potential.

Patients of different educational backgrounds could substitute differentially. Fig. 1c and Table A3 depict the marginal effects of substitution by education. We find that substitution in the highest educational stratum is 2.5 times larger than that in the lowest. That direction is also persistent when education is further interacted with ED accessibility. Regardless of whether ED accessibility is good or bad, well-educated people substitute more than less-educated people. Additionally, we found that household income has no significant effect on the substitution.

4.2. PCES and inpatient admissions via ED

Table 2 reports results for the substitution between inpatient short-stay admissions via the ED (length of stay <= 1 day) and PCES. Column 1 presents the results for our baseline Model (1). Column 2 shows the substitution by age group, and Column 3 shows the substitution for different degrees of urgency of the inpatient admissions. In general, we find significant substitution; however, it is eight times smaller than the substitution for ED visits not followed by admission (a 10% increase in PCES cases relates to a 0.3% decrease

Table 1
Determinants of the substitution of PCES and ambulatory ED visits.

ED visits (ambulatory)	(1)	(2)	(3)	(4)	(5)
PCES	−0.252***				
	(−10.99)				
Population	0.127**	0.115*	0.100*	0.103*	0.0789
	(2.86)	(2.52)	(2.24)	(2.33)	(1.76)
Hospital supply	0.0116	0.0116	−0.0285	−0.0214	−0.0256
	(0.12)	(0.12)	(−0.31)	(−0.21)	(−0.25)
PC supply	−0.0130	−0.0134	−0.00677	−0.0117	−0.0119
	(−0.34)	(−0.36)	(-0.18)	(−0.32)	(−0.31)
Paediatric supply	0.133	0.131	0.148	0.154	0.118
	(0.98)	(0.97)	(1.09)	(1.14)	(0.85)
*PCES*Age group*					
0-9		−0.194*			
		(−2.56)			
10-19		−0.419***			
		(−3.54)			
20-29		−0.304***			
		(−4.88)			
30-39		−0.313***			
		(−5.22)			
40-49		−0.311***			
		(−4.04)			
50-59		−0.258***			
		(−3.62)			
60-69		−0.245**			
		(−3.26)			
70-79		−0.201***			
		(−3.31)			
80-89		−0.176***			
		(−3.89)			
90-99		−0.150***			
		(−3.74)			
*PCES*ED Accessibility*					
Good			−0.337***		
			(−7.09)		
Average			−0.270***		
			(−8.03)		
Bad			−0.0373*		
			(−2.08)		
*PCES*PCES Accessibility*					
Bad				−0.272***	
				(-10.70)	
Average				−0.224***	
				(10.34)	
Good				−0.195***	
				(−8.96)	
*PCES*ED Accessibility*			*PCES Accessibility*		
Good x Bad					−0.383***
					(−8.05)
Good x Average					−0.338***
					(−7.67)
Good x Good					−0.305***
					(-7.10)
Average x Bad					−0.206***
					(−6.57)
Average x Average					−0.162***
					(-5.59)
Average x Good					−0.136***
					(-3.94)
Bad x Bad					−0.0853***
					(-4.65)
Bad x Average					−0.0391*
					(−2.04)
Bad x Good					0.00631
					(0.25)
δ_i	included	included	included	included	included
α_{2010}	base	base	base	base	base
α_{2011}	0.0498***	0.0515***	0.0525***	0.0520***	0.0538***
	(12.60)	(12.97)	(12.55)	(12.95)	(12.76)

Table 1 (*Continued*)

ED visits (ambulatory)	(1)	(2)	(3)	(4)	(5)
α_{2012}	0.120***	0.121***	0.124***	0.123***	0.126***
	(21.83)	(22.02)	(21.12)	(21.60)	(21.34)
α_{2013}	0.300***	0.303***	0.305***	0.303***	0.309***
	(35.21)	(35.09)	(33.69)	(34.48)	(33.54)
α_{2014}	0.324***	0.328***	0.332***	0.329***	0.334***
	(32.89)	(32.74)	(31.73)	(30.53)	(30.00)
constant	6.587***	6.757***	6.349***	6.625***	6.918***
	(6.18)	(6.27)	(5.93)	(6.11)	(6.21)
N	5,607	5,607	5,607	5,607	5,607
R-sq	0.282	0.285	0.289	0.290	0.298

Note: This table presents substitutional relationship between PCES visits and ambulatory ED visits. Presented estimates come from five fixed-effects models in which the ambulatory ED visits is the dependent variable and the PCES visits is the independent variable. Further controls are population size, supply of hospital beds, supply of primary care physicians and supply of paediatricians. Column 1 shows the baseline relationship, column 2 shows the substitutional relationship interacted with age group, column 3 shows the interaction with accessibility of the ED, column 4 the interaction with accessibility of the PCES and column 5 shows the relationship in a threefold interaction with both accessibilities. The level of observation is age group-gender-county-year level. Regression coefficients are reported as elasticities and interactions as marginal effects. Observations are weighted by underlying population size. Two-tailed significance levels: *p < 0.05; **p < 0.01; and ***p < 0.001. Numbers in brackets represent t-values. Robust standard errors are clustered at the age group-gender-county level.

in ED admissions). Since inpatient admission requires both the patient's decision to go to the ED and the ED physicians' decision to admit, this smaller elasticity appears reasonable. As a robustness check, we estimated elasticities for longer lengths of stay. We also found significant substitution that becomes progressively smaller from one to three days (-0.030, -0.027, -0.024). We also controlled for inpatient referrals, which did not change our results. As found for ambulatory ED visits, annual fixed effects indicate large growth of ED admissions due to unobserved factors; the increase between 2010 and 2013 is 17.4%.

Fig. 2a shows the marginal effects of inpatient substitution by age group (Table 2 Column 2). We only find considerable substitution for children under 10 years of age and for elderly persons between 70 and 90 years of age.

Fig. 2b shows the marginal effects of the substitution by urgency (Table 2 Column III). We find almost no substitutional potential between PCES and ED admissions that require urgent or very urgent inpatient treatment (i.e., actual inpatient emergency care). However, we find strong substitution for non-urgent or low-urgency ED admissions, which are twice as strong as in the baseline estimation. We find similar patterns for lengths of stay from one to three days.

5. Discussion

The analysis shows that there is considerable substitutional potential between primary care emergency services and EDs in Germany. Hence, we argue that efficient incentives for using the PCES can reduce ambulatory ED visits and decrease inpatient ED admissions. Our results confirm those of two recent empirical studies that also report significant negative relationships [6,19]. However, our comparability to these studies may have been limited by a number of differences in study design, methods and setting. A major difference between their work and ours is that the former analysed the effect of policies that extended supply (i.e., opening hours) in the primary care sector on ED utilization and thus provide unbiased estimations analysing natural experiments. Nevertheless, their percentage extension of primary care opening hours (Eight to 12 h and five to seven days) translates to a 0.25% and 0.248% reduction in ED visits in Bruni et al. [6] and Dolton and Pathania [19], respectively, which is in line with our estimated elasticity of 0.25. That provides confidence in our estimated elasticities and the potential bias due to unobserved time-varying heterogeneity, which we cannot account for using a FE identification strategy, does not appear to be too problematic.

Regarding ambulatory ED visits, we find the strongest substitutional potential for younger people and this potential decreases steadily from age 50, with the lowest potential found among the oldest age group. Worse mobility among older people might reduce their ability to substitute. Moreover, among the elderly, one would expect more severe cases that are less likely substitutable by PCES. The large effect size and confidence interval for teenagers (10–19) might appear because the decision of going to PCES or ED is taken by the patient's parents for the younger and by the patients themselves for the older individuals within that age group.

The accessibility of hospital EDs is decisive for the substitution. The strength of this substitutability in the range from bad to good ED accessibility differs four times more than for PCES accessibility. Moreover, a highly accessible ED fosters substitution, while a highly accessible GP prevents it. These results confirm the findings of Bruni et al. [6]. This seems to imply that wherever a hospital ED is quickly accessible, more people tend to substitute in favour of ED with little consideration of where the nearest provider of PCE**S** is. With other words, if an ED is well accessible individuals tend to prefer an ED over PCES.

At first glance, the higher substitution among well-educated neighbourhoods in contrast to less-educated ones is counter-intuitive. One would expect better-educated patients to have higher health literacy and to be better informed about the appropriate level of care and the availability of the PCES. Hence, one would expect lower substitution. However, if the self-perceived urgency of the condition is high, better educated individuals are likely to be aware of the fact that they may finally have to be admitted to hospital. In other words, they are better able to anticipate their higher opportunity costs compared to lower educated individuals and they try to avoid the time loss of a second physician contact in ED and are thus more likely to substitute PCES for ED visits. In the context of German health care, better educated persons are also more likely to know that PCES physicians are forced to provide those services beyond their duties within regular office hours which may lead to low motivation.

The results for those ED visits followed by hospitalization are generally in line with previous studies, which also found substitution for the provision of primary care services [16,19]. Kopetsch and Schmitz [16] report a substitutional relationship between general ambulatory services and hospitalizations. Dolton and Pathania [19] find that relationship for admissions from the ED in response to extended PC opening hours. As found in our study, the effect size was considerably smaller compared to the response to ambulatory ED visits.

Table 2
Determinants of the substitution of PCES and inpatient ED admissions.

ED admissions (short stay)	(1)	(2)	(3)
PCES	−0.0295***		
	(−3.77)		
Population	0.650***	0.645***	0.561***
	(22.64)	(22.14)	(20.88)
PC supply	−0.121	−0.120	−0.114
	(−1.86)	(−1.86)	(−1.71)
Paediatric supply	0.0120	0.0115	0.0203
	(0.56)	(0.54)	(0.93)
Hospital supply	−0.0457	−0.0475	−0.0555
	(−1.35)	(−1.40)	(−1.54)
*PCES*Age group*			
0–9		−0.107*	
		(−2.40)	
10–19		0.00683	
		(0.26)	
20–29		0.0234	
		(1.33)	
30–39		−0.00665	
		(−0.32)	
40–49		−0.000162	
		(-0.01)	
50–59		−0.00806	
		(−0.48)	
60–69		−0.0385	
		(−1.58)	
70–79		−0.0922***	
		(−6.03)	
80–89		−0.102***	
		(−4.50)	
90–99		0.0324	
		(0.96)	
*PCES*Urgency*			
Non urgent			−0.0605***
			(−3.71)
Low urgency			−0.0611***
			(−4.01)
Urgent			−0.00554
			(−0.44)
High Urgency			−0.0197*
			(−2.03)
δ_i	included	included	included
α_{2010}	base	base	base
α_{2011}	0.0709***	0.0697***	0.0747***
	(24.99)	(24.51)	(25.10)
α_{2012}	0.135***	0.134***	0.139***
	(43.10)	(42.55)	(41.86)
α_{2013}	0.178***	0.175***	0.174***
	(52.24)	(50.86)	(48.80)
constant	−1.352*	−1.275*	−1.993***
	(−2.51)	(−2.37)	(−3.64)
N	5891	5891	23,674
R-sq	0.331	0.334	0.116

Note: This table presents substitutional relationship between PCES visits and short stay ED admissions. Presented estimates come from three fixed-effects models in which the short stay ED admissions is the dependent variable and the PCES visits is the independent variable. Further controls are population size, supply of hospital beds, supply of primary care physicians and supply of paediatricians. Column 1 shows the baseline relationship, column 2 shows the substitutional relationship interacted with age group and column 3 shows the interaction four levels of urgency of the ED admissions (see further details in the text). The level of observation is age group-gender-county-year level in column 1 and 2 and age group-gender-county-urgency-year in column 3. Regression coefficients are reported as elasticities and interactions as marginal effects. Observations are weighted by underlying population size. Two-tailed significance levels: *p < 0.05; **p < 0.01; and ***p < 0.001. Numbers in brackets represent t-values. Robust standard errors are clustered at the age group-gender-county level.

We also confirm Dolton's results concerning patient age. The substitution is concentrated among elderly patients (older than 60 years in Dolton and Pathania [19] and 60–90 years in our study). In addition, we find substitution among children. As argued by the former, ED staff might be especially risk averse when treating elderly and child patients. Furthermore, ED admissions lack access to patients' medical histories, which may lead physicians to admit patients, but especially children and the elderly, due to higher uncertainty.

A difference between Dolton's work and ours is that the former assumes that ED admissions are generally urgent cases. Instead, we were able to categorize ED admissions by urgency. Patients with conditions that require urgent or very urgent inpatient treatment show little or no substitutional potential with PCES. Heading to the hospital ED is arguably the predominant option for these conditions. However, ED admissions with no or low urgency exhibit considerable substitution. For short-term, non-urgent admissions, the elasticity is approximately one-quarter of that for ambulatory ED visits.

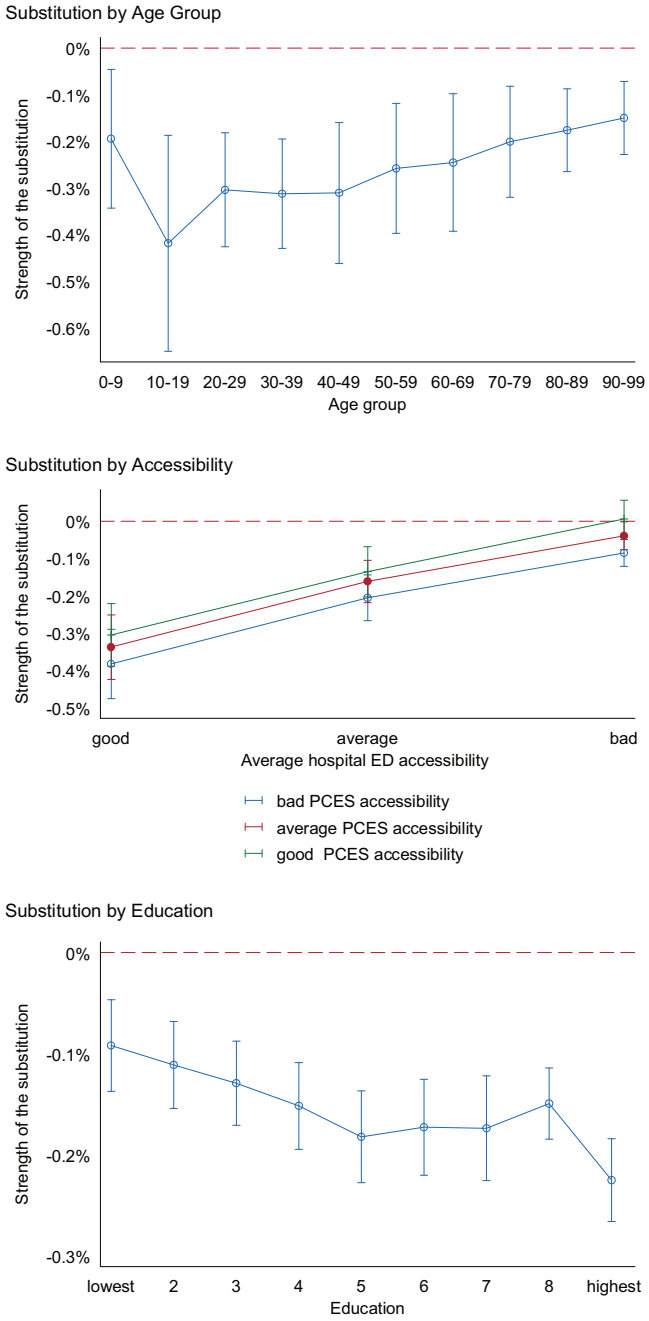

Fig. 1. This figure presents our estimates from Table 1 for the substitutional relationship between PCES visits and ambulatory ED visits. The x-axis shows the levels of interacting variables, the y-axis shows the marginal effect on ambulatory ED visits: (a) Substitution ambulatory ED visits by age groups (Table 1 Column 2). (b) Substitution ambulatory ED visits by hospital ED and PCES accessibility (Table 1 Column 5). (c) Substitution ambulatory ED visits by education (Table A3 Column 1) (please find further details in text).

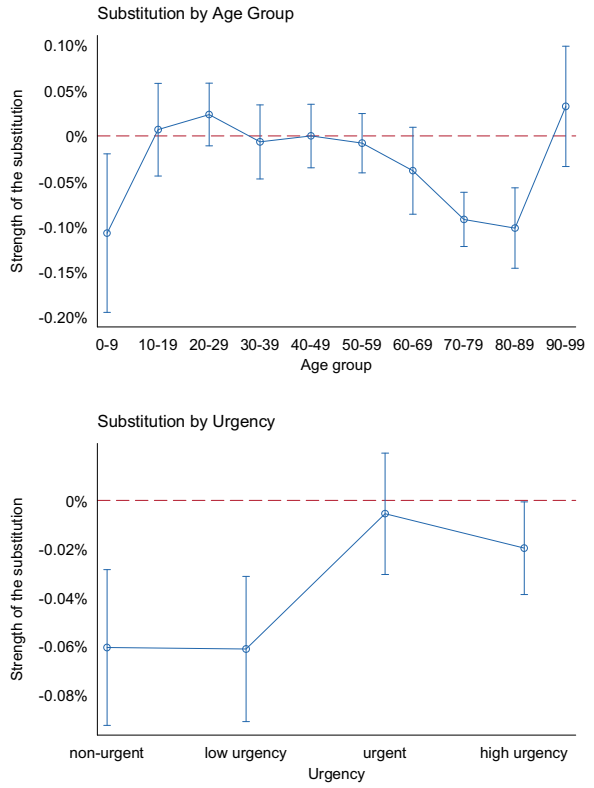

Fig. 2. This figure presents our estimates from Table 2 for the substitutional relationship between PCES visits and short stay ED admissions by different determinants as interaction effects with PCES. The x-axis shows the levels of interacting variables, the y-axis shows the marginal effect on short stay ED admissions: (a) Substitution inpatient ED admissions by age groups (Table 2 Column 2). (b) Substitution inpatient ED admissions by urgency (Table 2 Column 3) (please find further details in text).

Overall, substitution between ED admission and PCES is comparatively low on average for the total population, but quite large in certain areas. That concentration of the substitution in non-urgent, short-stay admissions for the elderly may also point towards unnecessary admissions. That would be crucial because even short inpatient stays represent very costly spillovers from the primary care sector. We argue that many of these admissions are likely to be in a grey zone in terms of the admission decision. Whether a patient is admitted for inpatient treatment (e.g., a short observational stay) or discharged after ambulatory treatment in the ED is frequently at the discretion of ED physicians, who operate as gatekeepers for inpatient care [4,23]. Particularly in Germany, hospitals are incentivized in favour of inpatient admission due to the country's a full coverage system in which hospital reimbursement is based on DRGs, which creates the inherent incentive to increase (profitable) admissions. In addition, the German ambulatory reimbursement rate for EDs is low and considered unprofitable [24].

5.1. Limitations

However, our study has some limitations. The use of a synthetic panel aggregated at county-specific demographic groups instead of individual data was the cost of combining German outpatient and inpatient data sources that depict three-quarters of the entire market. As a novelty, we were able to stratify ED admissions by urgency. Unfortunately, we were unable to differentiate ambulatory ED visits with respect to urgency. Finally, generalization to other health care systems should be treated with caution. In particular, the relationship between PCES and inpatient admissions may vary by the system-specific incentives, coverage and availability of resources of different health care systems.

6. Conclusion

To the best of our knowledge, this paper provides the first empirical evidence on the relationships between different sectors of emergency care provision in Germany. Based on an extensive longitudinal dataset, the current study provides evidence for both substitution between PCES and ambulatory ED visits as well as inpatient admission from EDs. Intuitive results for various deter-

minants of the strength of the substitution lend confidence to our estimations. We argue that substitutable cases can be more efficiently treated in a primary care setting and thus respond to ED overcrowding and hospital admissions of questionable necessity.

Countries with no gate-keeping system (such as Germany) have difficulties redirecting the patients streaming to EDs [25]. However, our estimated elasticities can help policy makers to resolve this issue, as our findings indicate where incentivizing the utilization of PCES is particularly effective. Thus, they can help to create targeted policies.

A feasible approach might be to establish integrated emergency centres on hospital sites that integrate emergency department services and primary care emergency services. We find hospital location to be decisive for patients. Moreover, in areas with poor hospital accessibly, we find no considerable substitutional potential anyway. If needed, hospital resources and specialty care would then be on-site. By adopting this structure, patients could be guided to the individually appropriate level of care. After an initial assessment, performed independently by non-hospital employees, they could be treated by primary care emergency services or referred to the hospital ED or inpatient treatment. Non-urgent cases could be rescheduled to a usual primary care appointment. Importantly, the admission decision would be shifted to the responsibility of physicians outside the economic entity of the hospital who are not subject to the incentive to admit.

However, our estimations indicate high growth rates for both ambulatory treatments in and inpatient admission from EDs that are unrelated to PCES, which future research should further attempt to explain. It seems particularly fruitful to examine admission behaviour in EDs, especially if hospital reimbursement is based on DRGs with inherent incentives to admit potentially profitable patients. A reduction in unnecessary admissions could release substantial resources.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.healthpol.2019.08.013.

Declaration of Competing Interest

None.

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