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ACCESS TO PRIMARY HEALTH CARE AND HEALTH OUTCOMES: THE RELATIONSHIP BETWEEN GP CHARACTERISTICS AND MORTALITY RATES

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Access to Primary Health Care and Health Outcomes:
The Relationships between GP Characteristics and Mortality Rates*

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Abstract

This paper analyses the impact of economic conditions and access to primary health care on health outcomes in Norway. Total mortality rates, grouped into four causes of death, were used as proxies for health, and the number of general practitioners (GPs) at the municipality level was used as the proxy for access to primary health care. Dynamic panel data models that allow for time persistence in mortality rates, incorporate municipal fixed effects, and treat both the number and types of GPs in a district as endogenous were estimated using municipality data from 1986 to 2001. We reject the significant relationship between mortality and the number of GPs per capita found in most previous studies. However, there is a significant effect of the composition of GPs, where an increase in the number of fee-for-service GPs reduces mortality rates when compared with GPs employed directly by the municipality.

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Keywords: general practitioners (GPs), mortality, morbidity, simultaneity, endogeneity, municipalities, dynamic panel data models

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1. Introduction

The health sector has grown rapidly in most developed countries over the last few decades. Government decisions affect the allocation of resources both to and within the sector. To evaluate the effectiveness of medical intervention without market prices, it is necessary to know the cost and returns to resource use and interventions in the sector. The key outcome of most health intervention is reduced mortality and morbidity, and better quality of life.

Three different lines of research on mortality can be identified in the economic literature. Some studies have analysed the relationship between economic resources and health outcomes. Most of these papers focus on the effects of economic conditions such as unemployment rates or aggregate measures of income on mortality (e.g., Auster et al., 1969; Forbes and McGregor, 1984; Gravelle, 1984; Leu, 1986; Hitiris and Posnett, 1992; Grubaugh and Santerre, 1994; Joyce and Mocan, 1997; Ruhm, 2000, 2003; Cutler et al., 2002). Other studies have focused on mortality rates at the hospital level, where resource use, policy changes relating to reimbursement rates, doctor and nurse staffing, managed care, and technological change are important explanatory factors for mortality rates (e.g., Cutler, 1995; McClellan and Noguchi, 1998; Hartz et al., 1989; Manheim et al. 1992; Kessler and McClellan, 2000; Geweke et al., 2003; Mark et al., 2004). A third line of research has focused on the effect of the number of physicians or general practitioners (GPs) in a district (usually US state level or national level) on mortality (e.g., Auster et al., 1969; Grubaugh and Santerre, 1994; Robst and Graham, 1997; Robst, 2001; Or, 2000, Or et al., 2005).

In our study, we analyse the relationship between access to primary care (proxied by the number of GPs at the municipality level) and health outcomes (proxied by mortality rates divided into four groups of causes of death) within a health production function framework (see Auster et al., 1969). Mortality rates change over time and vary substantially across municipalities, largely because of age and gender differences, but also due to other factors.[1] The number of GPs may affect mortality, but mortality may also affect the future number of GPs in a district. This creates a simultaneity problem, not previously handled in a panel data framework for this line of research, which may seriously bias the results from previous studies. In addition, there is a high degree of persistence in mortality rates over time. We estimate an econometric panel data model that accounts for the simultaneity problem between GPs (both the number and type) and mortality rates, incorporates municipality fixed effects, and allows for the influence of past mortality rates of current rates, using longitudinal data for 435 municipalities over a 16-year period from 1986 to 2001.

Using standard econometric techniques previously used in the literature (i.e., fixed-effects models) we find a negative effect of the per capita number of GPs on mortality rates. However, we do not find any significant effect of GPs on mortality rates once we allow for simultaneity between number of GPs and mortality rates in our dynamic regression model. This contradicts several studies that have found significant and negative effects of the number of GPs on mortality (Grubaugh and Santerre, 1994; Robst and Graham, 1997; Robst, 2001; Or et al., 2005).[2] However, we find a significant effect of the composition of GPs, where more fee-for-service GPs reduce mortality rates compared with GPs employed directly by the municipality.

The paper proceeds in Section 2 with a description of the institutional settings for the primary health care sector relevant for this study. Section 3 presents data used in the analysis, with descriptive statistics. A discussion of the econometric model used in analysing the relationship between mortality and access to health care follows in

[1] Mortality is only one measure of health status. Morbidity and other subjective indicators of well-being are also likely to be affected by economic factors. There is a huge literature on the relationship between socio-economic condition and self-reported measures of health. We use mortality rates because this measure of health is easily quantifiable and has been precisely measured over time. A closely related alternative to mortality rates would be the expected average length of life at birth. The correlation between mortality rates and life expectancy is very high, around 0.9. However, the expected average length of life varies for different causes of death. This is not the case for mortality rates. Thus, the mortality rate is a consistent measure of health between different causes of death, and makes our study comparable with studies from other countries. We divide causes of death in the estimation of mortality rates into four groups: a) malignant neoplasm (cancer); b) diseases of the circulatory system (cerebrovascular diseases, ischaemic heart diseases, and other heart diseases); c) diseases of the respiratory system (for example, pneumonia, bronchitis, emphysema, and asthma); and d) other causes (such as accidents, suicide, diseases of the digestive system, and mental disorders).

[2] These studies use country-level or state-level data (USA).

Section 4. The paper discusses the empirical results of the regression analysis in Section 5, and gives concluding remarks in Section 6.

2. Institutional settings in the primary health care sector

Responsibility for health services in Norway is rooted in the public sector.[3] The public health system is under the jurisdiction of the Ministry of Health and Social Affairs, which is responsible for devising and monitoring national health policy. Responsibility for provision of services is decentralized to municipal and regional (county) administrative levels.[4]

Counties provide specialized medical services, including general and psychiatric services and others such as laboratory, radiography, and ambulance services. Primary health care, including both preventive and curative treatment, is in the hands of municipalities. Municipalities are required by law to offer services for disease prevention and health promotion, diagnosis and treatment of illness, rehabilitation, and long-term care. There are no defined minimum standards regarding level or quality of health services.

The primary health care sector is financed through grants from municipalities, retrospective reimbursement by the National Insurance Scheme (NIS) for services supplied, and out-of-pocket payments by patients. Major responsibilities of the Norwegian primary health care sector can be grouped as follows. Firstly, municipalities have responsibility for the promotion of health and prevention of illness and injuries, including organizing and running school health services, health centres, and child health care by health visitors, midwives, and physicians. Secondly, municipalities have responsibility for diagnosis, treatment, and rehabilitation, including general medical treatment, physiotherapy, and nursing. Thirdly, municipalities have responsibility for nursing and care within and outside institutions, including running nursing homes, home nursing, and several other activities.

[3] For a more thorough description of the Norwegian health sector, see van der Noord et al. (1998).
[4] The national authorities have retained some delivery mandates as well, including the control of several national councils, research institutions, the National Hospital of Norway (Rikshospitalet), the National Cancer Hospital (Radiumhospitalet) and a few other highly specialized hospitals.

The total number of GPs per 1000 capita increased from 0.9 in 1986 to 1.1 in 2001.[5] Two groups of GPs provide primary health services: GPs employed by the municipality, and self-employed GPs contracted to the municipality (fee-for-service GPs). Both employed and fee-for-service GPs work separately from hospital services and provide the first contact between patients and health services. Salaried physicians employed by the municipality typically work at health centres, often in group practice with other physicians. They are on a fixed salary, and the municipality generally determines their working hours and tasks. Fee-for-service physicians have a contract with the municipality to cover some expenses (about 30 per cent of physicians' gross income). As well, they obtain income from patient fees and a fixed fee reimbursement scheme from the National Insurance Administration. Contract physicians can, largely, make their own decisions about the number of hours worked. The proportion of contract physicians has increased from 0.39 in 1986 to 0.56 in 2001.

Municipalities have a legal obligation to employ physicians to carry out certain administrative, emergency, and clinical functions. Beyond this, there is no legislation regarding minimum requirements for physician–patient ratios. However, in order to secure a geographically balanced distribution of doctors, a commission comprising members from the central government and the Norwegian Medical Association (NMA) regulates the establishment of new positions for both GPs and hospital specialists. This means that municipalities need approval from the commission to establish new physician positions. Municipalities have an average gross expenditure of NOK 700 per inhabitant (84 euro) for each GP. Expenses vary from around NOK 500 (60 euro) per inhabitant for the largest municipalities to around NOK 2300 (277 euro) per inhabitant for the smallest municipalities.

3. Data and descriptive statistics

We use data from Norwegian municipalities for the 16-year period from 1986 to 2001. Data were gathered from Statistics Norway and from the Norwegian Social

[5] The number of GPs per 1000 capita varies in different countries: France (1.6), Germany (1.1), Italy (0.9), Sweden (0.5), UK (0.6), and USA (0.8).

Science Data Services (NSD). The health outcomes reported here are total mortality rates and deaths due to four groups of causes. The classification of causes of deaths follows the ICD-10 system classification system. The four main groups are: C = malignant neoplasm (cancer); I = diseases of the circulatory system (cerebrovascular disease, ischaemic heart disease, and other heart diseases); J = diseases of the respiratory system (for example, pneumonia, bronchitis, emphysema, and asthma); and O = other causes (for example, accidents, suicide, diseases in the digestive system, and mental disorders).[6] Table 1 explains the variables and Table 2 gives descriptive statistics for different measures of mortality and explanatory variables we use in the empirical analyses.

Total mortality and most specific mortality rates have declined over time, although the changes over the 16-year period in this analysis were small (see Table 2).[7] Total mortality rates have decreased from 11.1 per 1000 inhabitants in 1986 to 10.8 in 2001. Mortality group C (cancer, etc) has increased from 2.3 per 1000 inhabitants in 1986 to 2.7 per 1000 inhabitants in 2001. Diseases in the circulatory system (group I in the ICD-10 classification system) are the most common causes of death in the statistics. The numbers in this group decreased from 5.6 deaths per 1000 inhabitants in 1986 to 4.6 in 2001. As a percentage of all deaths, this group decreased from 50 per cent in 1986 to 42 per cent in 1992. The numbers for group J (respiratory diseases) varies from year to year, with a peak in 1993. Figure 1 measures the percentage change in mortality rates using 1986 as a reference point, and depicts the fluctuations in specific mortality rates over time.

There has been an increase from 0.90 physicians engaged in primary health care per 1000 inhabitants in 1986 (around 3200 GPs) to 1.10 physicians per inhabitant in 2001 (around 4100 GPs) (see Table 2 for details). Most of these GPs are engaged in

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[6] We do not focus on infant mortality because deaths among the youngest do not contribute significantly to the improvement of life expectancy in Norway as they did during the first half of the 20th century. Each year, of the total of around 56,000 births, fewer than 200 children die before the age of one. In the USA, more than two-thirds of life expectancy improvements resulted from reductions in mortality for those over the age of 45 years (Cutler and Meara, 2001).

[7] Mortality rates also vary substantially across municipalities. The 10-percentile mortality rate in 2001 was 7 per 1000 inhabitants, and the 90-percentile mortality rate at the municipality level was around 16 per 1000 inhabitants. Some of the variation in mortality is obviously due to the fact that many municipalities are small in terms of population. In these small municipalities one or two deaths will have a large influence on mortality rates, and we have therefore dropped observation with mortality rates lower than the 5 % percentile and higher than the 95 % percentile.

diagnosis, treatment, and rehabilitation (3375 person-labour years in 2001).[8] The corresponding figures for physicians working in the school health services/child health care and nursing homes/other institutions were 231 and 249, respectively. There has been a steady increase in the number of GPs at the municipality level over time. The increase in the number of GPs was 20 per cent from 1986 to 2001 (see Figure 2 for more details).

The number of GPs per 1000 inhabitants varies significantly across municipalities. Contrary to most OECD countries, Norway has a relatively high per 1000 capita supply of GPs in rural compared with urban areas, and the number of physicians per 1000 inhabitants is higher in rural areas than in urban municipalities. This is partly due to the legal obligation for even the smallest municipalities to employ a GP. In addition, the administrative and emergency component of primary health care requires more physicians per inhabitant in small municipalities. The number of physicians per 1000 inhabitants was 1.32 in rural areas in 2001. These municipalities have on average around 3000 inhabitants. In urban municipalities, with an average population of around 14,000 inhabitants, the number of physicians per 1000 inhabitants was 0.92 in 2001.[9]

Most GPs prefer to work in larger cities and municipalities. Thus, many smaller municipalities have difficulty attracting GPs to work for them. The number of vacant GP positions per 1000 inhabitants was around 0.06 in both 1986 and 2001. This is around 6 per cent of all GPs. However, the numbers of vacant positions vary from year to year (see Figure 2). The number of vacant GP positions per 1000 inhabitants was only 0.05 in 1994 compared with 0.10 per 1000 inhabitants in 2000. As is clear from Figure 2, the fluctuation in numbers of vacant GP positions does not follow a systematic pattern. However, the new patient list system was introduced in 2001, making it more attractive to hold a GP position compared with other type of positions

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[8] These data are only available from 2001.

[9] The percentage of municipalities defined as urban and rural has been constant over time in the data set we are analysing. Since our fixed-effects model assumes time-varying variables, the rural–urban distinction is not included as a variable in the regression. An alternative estimation strategy would be to run regressions for urban and rural municipalities separately, which we did in an earlier version of the paper. The results from these regressions are not included in this paper. We have included interaction terms between GPs and population size, and also interaction terms between vacant GPs and population size. The effect of these interaction terms on mortality rates was not significantly different from zero, and they are not included in the final regressions.

for medical doctors. This can explain the drop in number of vacant GP positions in 2001.

The number of fee-for-service GPs versus independent GPs also varies considerably between municipalities and over time. The number of fee-for-service GPs increased from 0.39 in 1986 to 0.56 per 1000 inhabitants in 2001 (see Table 2). The ratio of fee-for-service GPs over total number of GPs increased from 39 per cent in 1986 to 51 per cent in 2001. For more details about the change in the number of fee-for-service GPs and total number of GPs over time, see Figure 3.

Table 2 shows that the population is ageing, which is evident even for the short period 1986–2001. In 1986, 3.9 per cent of the population was above the age of 80 years. By 2001, this proportion had increased to 5.1 per cent. This is an increase of 30 per cent over a 15-year period. The population between 67 and 79 years has decreased slightly from 11.2 per cent in 1986 to 10.1 per cent in 2001.

4. Econometric issues

The aim of this paper is to examine the relationship between the availability of physicians and health outcomes in Norwegian municipalities. To investigate factors that determine the health status of a population, an aggregate health production function is a natural starting point. That means that we consider the health status of a municipality's population as the outcome of a production process where medical and non-medical resources or characteristics are used as inputs. As described in the previous section we use mortality per 1000 inhabitants (total mortality and four specific mortality measures) as a measure of health outcomes. Our key explanatory variables are the ones that measure different aspects of each municipality's workforce of GPs: "number of GPs", "number of vacant GP positions", and "number of fee-for-service versus employed GPs". In order to estimate reliably the effects of these variables, we must address several problems. We start by describing what we consider the three main problems to be, and thereafter we present an econometric model that has potential for solving these problems.

First, even though we control for a number of municipal characteristics, municipalities are likely to have unmeasured attributes (lifestyle factors like tobacco and alcohol consumption, number of health care personnel other than physicians, capacity in institutions for elderly, distance to hospitals, etc) that may affect mortality rates. These unobserved factors are most likely correlated with the explanatory variables, and, unless controlled for in the regressions, this leads to an omitted variable bias. Therefore, incorporating municipal fixed effects seems particularly important in this analysis.

Second, another source of omitted variable bias is an assumption that health status is static, i.e., explained solely by contemporaneous characteristics and circumstances. While contemporary circumstances obviously affect the health status of a population, current health will also depend on previous health. To control for this omitted variable bias, a dynamic panel data model is needed.

Third, as noted in a seminal paper by Auster et al. (1969), the direction of causality between health status and number of physicians is not clear. In municipalities whose populations are exposed to an increased risk of death, the demand for physician services is probably particularly high. The variables "vacant GP positions" and "contract GPs" are probably endogenous as well, and not controlling for this will result in biased estimates of the effect of these variables.

To consider these issues, we specify the following dynamic health production function:

$$M_{it} = \beta_0 + \gamma M_{i,t-1} + \alpha GP_{it} + \beta X_{it} + f_i + e_{it}\,, \qquad (1)$$

where M_{it} is the mortality rate in municipality *i* at time *t*, and $M_{i,t-1}$ is the mortality rate in municipality *i* in the previous period. By including previous values of mortality we allow for the possibility that current health depends on past health status through a partial adjustment mechanism. GP_{it} is a vector of GP variables where all three variables are treated as endogenous, X_{it} are other explanatory and control variables,

f_i is an unobserved municipality-specific time-invariant effect, and e_{it} is a disturbance term. This is a dynamic panel data model and may be estimated by standard GMM methods. First, equation (1) is first-differenced to get rid of the municipality fixed effects f_i, which may be correlated with the right-hand side variables of interest. With *T* time periods, the estimating dynamic health production function becomes

$$\Delta M_{it} = \gamma \Delta M_{i,t-1} + \alpha \Delta GP_{it} + \beta \Delta X_{it} + \Delta e_{it}, \; t = 2,...,T, \tag{2}$$

where Δ is the difference operator ($\Delta M_{i,t} = M_{i,t} - M_{i,t-1}$ etc.). Differencing eliminates the municipal-specific effect, but introduces a new bias. By construction the new error term, $\Delta e_{it} = e_{it} - e_{i,t-1}$ is correlated with the lagged dependent variable $\Delta M_{i,t-1} = M_{i,t-1} - M_{i,t-2}$. Notice however that $M_{i,t-s}$ and $\Delta M_{i,t-s}$ are uncorrelated with Δe_{it} and therefore are valid instruments for $s \geq 2$ (serial correlation has been ruled out by assumption). Arellano and Bond's (1991) GMM estimator exploits all possible moment restrictions in levels for each period $t \geq 3$. The number of available restrictions increases with *t*:

$$\begin{aligned}
&t = 3: E(\Delta e_{i3} M_{i1}) = 0, \\
&t = 4: E(\Delta e_{i4} M_{i1}) = 0, E(\Delta e_{i4} M_{i2}) = 0 \\
&t = 5: E(\Delta e_{i5} M_{i1}) = 0, E(\Delta e_{i5} M_{i2}) = 0, E(\Delta e_{i5} M_{i3}) = 0, \text{etc.}
\end{aligned}$$

In the case where the explanatory variables are assumed to be endogenous they are treated symmetrically with the dependent variable. In our case, we assume the GP variables (the *GP*-vector) to be endogenous, and the lagged values $GP_{i,t-2}$, $GP_{i,t-3}$, etc. are therefore valid instruments for periods $t = 3,4,...,T$. The rest of the explanatory variables (the *X*-vector) are treated as strictly exogenous, so this entire vector is also available as instruments.

Utilizing these moment conditions, a two-step GMM estimator can be used to estimate the differenced equation. More recently, Arellano and Bover (1995) and Blundell and Bond (1998) show that the efficiency of the Arellano and Bond (1991)

GMM estimator may be dramatically improved by using an extended system GMM estimator that uses lagged differences as instruments for equations in levels, in addition to lagged levels of the instruments for equations in first differences. In this paper, we report both the “ordinary” GMM and “system” GMM results. The validity of the over-identifying restrictions may be tested using a Sargan test. If the e_{it} are serially uncorrelated, then the residuals in the first-differenced model are first-order correlated, but should not show any second-order serial correlation. These restrictions may be tested (see Arellano and Bond, 1991, or Blundell and Bond, 1998).

5. Empirical results

In Table 3 we report results from static (OLS and fixed-effects) and dynamic (GMM and GMM-SYS) health production functions. Focusing first on the dynamic models, we note that the specification tests are satisfactory[10]. The Sargan tests do not reject the over-identifying restrictions and the tests regarding serial correlation reject the absence of first-order, but not second-order serial correlation. The dependent variable in the regressions in Table 3 is the total mortality rate in the municipalities. From the dynamic models we see that the lag of the dependent variable is positive and significant. This certainly rejects a static model, previously used in the literature, in favour of a dynamic and indicates some degree of persistence in the mortality ratio over time. Further, the estimated effect of most explanatory variables differs both between the dynamic and static models and between the GMM and GMM-SYS models. Most important is that the conclusions regarding the three GP variables differ substantially between the models.[11]

[10] Results are reported for two-step GMM and GMM-SYS estimators. However, one- and two-step results are very similar.

[11] We have included many different variables for other types of medical personnel in our regressions, such as per capita number of nurses (different types), total number of employed persons in primary care except GPs, etc. We have also included measures for total expenditures on primary care. These variables were not significantly different from zero and did not affect the main variables in our regressions. Thus, we have dropped these variables from the regressions reported in this paper.

In the static models, the variable measuring the number of GPs in the municipality is positive, but insignificant.[12] If anything, this indicates that the mortality rate increases with the number of physicians in the municipality. The variable "number vacant GP positions" is positive and significant, indicating that an increased number of vacant positions increase the mortality rate. The last variable measuring contract GPs is negatively significant in the fixed-effects model, but insignificant in the OLS model. However, these variables are probably endogenous. For example, the number of GPs is most likely simultaneously determined and not controlling for this endogeneity problem will lead to an upward-biased estimate of the variable (since municipalities where the mortality rate is high on average tend to have more physicians per inhabitant than elsewhere).

In the two dynamic models (GMM and GMM-SYS) the number of GPs, vacant GPs and contract GPs are treated as endogenous. From Table 3 we see that the estimated effects of the GPs variables are quite different from those in the static models. In both the GMM and GMM-SYS models, the coefficient on the number of GPs has the expected negative sign, but is still insignificant[13]. The coefficient on vacant GPs goes from positive and significant in the fixed-effects model to negative and insignificant in the dynamic models. Thus, given the current level of GPs, neither of them affects total mortality rates. The composition of GPs, on the other hand, seems to have some influence on the mortality rate. More fee-for-service GPs compared with GPs employed by the municipality decreases mortality rates. However, this effect is only significant in the GMM-SYS model, and only at the 10 per cent level.

In Table 4 we present results from GMM-SYS models where we distinguish between four groups of mortality rates (cancer, circulatory system, respiratory system, and other causes). Our conclusions regarding the GP variables remain the same, however. The effect of number of GPs is negative, but insignificant in all four models. Given the current level of GPs, vacant positions have no effect on mortality rates. Increasing

[12] Notice however, that the number of GPs is negative and significant if we run regressions without the vacant GPs variable. The number of vacant GP positions may be interpreted as measuring unmet demand.

[13] We have estimated several models where we included lags on the physician variable. However, these lags were not significant.

the number of fee-for-service GPs compared with the number of employed GPs reduces mortality rates, but only for mortality group C (cancer) and O (other causes).

Looking at the other explanatory variables, it is not surprising to find age is an important variable explaining mortality rates at the municipality level. A larger proportion of persons in the age groups 67 to 79 and above 80 significantly increase the mortality rate. These effects are found in all models, except for mortality J (respiratory diseases) in the age group 67–79. Leu (1986) found that the proportion of the population over 65 years of age was the most important determinant of differences in crude mortality rates among countries.

We find a significant negative effect of education on mortality rates, where we use the proportion of persons with education at high school level or higher as the explanatory variable. Many studies have found a significant link between schooling and health status (Auster et al., 1969; Grossman, 1972; Kemna, 1987). Fuchs (1998) also pointed to the striking negative correlation between number of years of schooling and mortality, especially for the USA. The effect of education on mortality in our data is small in terms of absolute value. One predicts an increase of around 100 persons in the highest educational group to reduce the number of deaths. However, we do not find the same clear effect of education when we divide mortality into different causes of death. Table 4 shows that this effect is significant only for mortality due to diseases of the respiratory system (group J). See also Bosma et al. (1999) and Deaton and Paxson (1999) for a discussion of the effect of education on mortality rates.

In our study, we find a non-significant relationship between unemployment and mortality except for the wrongly specified OLS model. Ruhm (2000) analysed the relationship between unemployment and total (and age-specific) mortality rates, using US state level data for the 1972–1991 period. He found that total mortality exhibited a procyclical variation. However, the expected life span in Norway at birth is 82 years for females and 77 years for males. Thus, most people who die are pensioners, and the non-significant coefficient on unemployment is as expected.[14]

[14] Cutler et al. (2002) used time series data from Mexico to analyse the relationship between mortality and economic crises. They found that mortality rates increased with economic crises, among the elderly and possibly among the very young. They discussed the reasons for an inverse relationship between

6. Concluding remarks

This study found no significant relationship between mortality rates and the per capita number of GPs in a model that a) incorporates municipal fixed effects to allow for unmeasured factors, b) allows for time persistence in mortality rates, and c) treats the number of GPs in a district as endogenous. However, there is a significant effect of the composition of GPs, where the presence of more independent contract GPs reduces mortality rates compared with situations where more of the GPs are employed by the municipality.

Patients uniformly complain about long waiting times and lack of personal contact with GPs, as reflected in short consultations and long waiting times before the consultation takes place (Johnsen and Holtedahl, 1997). Since contracted self-employed GPs are paid by number of consultations and activity, there is an incentive for increased productivity and possible better quality in self-employed GP practices compared with where GPs are employed by the municipality on fixed salaries. Fixed salary contracts are sometimes used to recruit and retain GPs, especially in rural municipalities where the turnover rate can be high. Carlsen and Grytten (2000) found that places where relatively more physicians are municipally employed were associated with lower consumer satisfaction. The link between employed GPs and satisfaction can be explained by longer waiting times and thus poorer access to health care, and possibly also lower quality of care. These mechanisms can explain the positive effect on mortality rates of an increase in contract GPs relative to employed GPs.

This study cannot be used to determine the optimal number of GPs at the municipality level. We focused on the marginal effect of GPs from the current level of the per capita number of GPs. Given that we measured the effect of additional GPs on mortality rates, it is difficult to judge the effect and benefits of GPs, and compare them with the costs, because the effect on mortality is not usually translated into

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mortality and economic crises. These were: 1) economic downturns reduce income, which reduces resources for consumption and investment of goods that improve or maintain good health; 2) economic downturns reduce public spending on health, which may affect groups particularly dependent on the public health system; and 3) crises and economic conditions affect the informal care that families can provide for children and the aged.

monetary equivalents. What is one extra year of life worth for one person and can this be compared with the cost to society of an extra GP? An alternative research strategy could measure cost per quality-adjusted life years (QALY). This measure combines both saved life years and quality of life, and could be used to compare the cost-effectiveness of different interventions. We did not have measures of quality of life at the municipality level, and such a measure is not usually available for this type of research. Future work will show if extra GPs affect the quality aspects of life rather than only crude mortality rates.

Even though we found no effect of additional GPs at the current level on mortality rates, we did find a positive effect on mortality rates from increasing the number of self-employed contract GPs relatively to GPs employed by the municipality on fixed salary contracts. Employed GPs have weaker incentives to see patients when compared with contract (fee-for-service) GPs, resulting in poorer access to care and quality of care.

References

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58, 277–297.

Arellano, M., Bover, O., 1995. Another look at the instrumental-variable estimation of error-components models. Journal of Econometrics 68, 29–52.

Auster, R., Leveson, I, Sarachek, D., 1969. The production of health, an exploratory study. Journal of Human Resources 4(4), 411–436.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87, 115–143.

Bosma, H., Schrijvers, C., Mackenback, J.P., 1999. Socioeconomic inequalities in mortality and importance of perceived control: cohort study. British Medical Journal 319(4), 1469–1470.

Carlsen, F., Grytten, J., 2000. Consumer satisfaction and supplier induced demand. Journal of Health Economics, 19, 731–753.

Cutler, D.M., 1995. The incidence of adverse medical outcomes under prospective payment. Econometrica 63(1), 29--50.

Cutler, D.M., Meara, E., 2001. Changes in the age distribution of mortality over the 20th century. NBER Working Paper 8556.

Cutler, D.M., Knaul, F., Lazano, R., Mendez, O., Zurita, B., 2002. Financial crisis, health outcomes and aging: Mexico in the 1980s and 1990s. Journal of Public Economics 84, 279–303.

Culyer, A. J., Jonsson, B. (Eds.), 1986. Public and private health services: complementarities and conflicts. Oxford and New York: Blackwell 1986; 41–63.

Deaton, A., Paxson, C., 1999. Mortality, education, income and income inequality among American cohorts. National Bureau of Economic Research Working Paper: 7140, October 1999.

Fuchs, V.R., 1998. Who Shall Live? Health, economics, and social choice. Economic ideas leading to the 21st century – Vol 3. World Scientific. Singapore.

Forbes, J.F., McGregor, A. 1984. Unemployment and mortality in post-war Scotland. Journal of Health Economics 3, 239–257.

Geweke, J., Gowrisankaran, G., Town, R.J., 2003. Bayesian inference for hospital quality in a Selection Model. Econometrica 71(4), 1215–1238.

Gravelle, H., 1984. Time series analysis of mortality and unemployment. Journal of Health Economics 3(3), 297–305.

Grossman, M., 1972. On the concept of health capital and the demand for health. Journal of Political Economy 80(2), 223–255.

Grubaugh, S.G., Santerre, R.E., 1994. Comparing the performance of health care systems: an alternative approach. Southern Economic Journal 60(4), 1030--1042.

Hartz, A.J., Krakauer, H., Kuhn, E.M., Young, M., Jacobsen, S.J., Gay, G., Muenz, L., Katzoff, M., Bailey, R.C., Rimm, A.A., 1989. Hospital characteristics and mortality rates. New England Journal of Medicine 321(25), 1720–1725.

Hitiris, T., Posnett, J., 1992. The Determinants and effects of health expenditure in developed countries. Journal of Health Economics 11, 173–181.

Johnsen, R., Holtedahl, K.A., 1997. Arbeidstid og produksjon av curative tjenester i allmennpraksis i 1993. Tidsskrift for Den norske lægeforening 117, 1489–1492. (In Norwegian).

Joyce, T., Mocan, N.H., 1998. Unemployment and infant health: time-series evidence from the state of Tennessee. Journal of Human Resources 28(1), 185–203.

Kemna, H.J.M.I., 1987. Working conditions and the relationship between schooling and health. Journal of Health Economics 6(3), 189–210.

Kessler, D., McClellan, M., 2000. Is hospital competition socially wasteful? Quarterly Journal of Economics 115, 577–615.

Kjevik, J., 2004. Kommunenes utgifter til primærlegetjenesten 2002, Statistics Norway 2004/6 (In Norwegian).

Leu, R.E., 1986. Public–private mix and international health care costs, in: Culyer, A. J., Jonsson, B. (Eds.) 1986.

Manheim L.M., Feinglass, J., Shortell, S.M., Hughes, E.F., 1992. Regional variation in Medicare hospital mortality. Inquiry 29(1), 55–66.

Mark, B.A., Harless, D., McCue, M., Xu, Y., 2004. A longitudinal examination of hospital registered nurse staffing and quality of care. Health Services Research 39(2), 279–300.

McClellan, M., Noguchi, H., 1998. Technological change in heart-disease treatment: does high tech mean low value? American Economic Review Paper and Proceedings, 88, 90–96.

Or, Z., 2000. Determinants of health outcomes in industrialised countries: a pooled, cross-country time-series analysis, OECD Economic Studies, No. 30, 2000/1.

Or, Z., Wang, J., Jamison, D., 2005. International differences in the impact of doctors on health: a multilevel analysis of OECD countries. Journal of Health Economics, 25, 531–560.

Robst, J., 2001. A Note on the relationship between medical care resources and mortality. Applied Economic Letters 8, 737–739.

Robst, J., Graham, G.G., 1997. Access to health care and current health status: do physicians matter? Applied Economic Letters 4, 45–48.

Ruhm, C., 2000. Are recessions good for your health? Quarterly Journal of Economics 115(2), 617–650.

Ruhm, C., 2003. Good times make you sick. Journal of Health Economics 22, 637–658.

Van der Noord, P., Hagen, T., Iversen, T., 1998. The Norwegian health care system. Economics Department Working Papers 198, OECD.

Figure 1. Changes in mortality rates over time

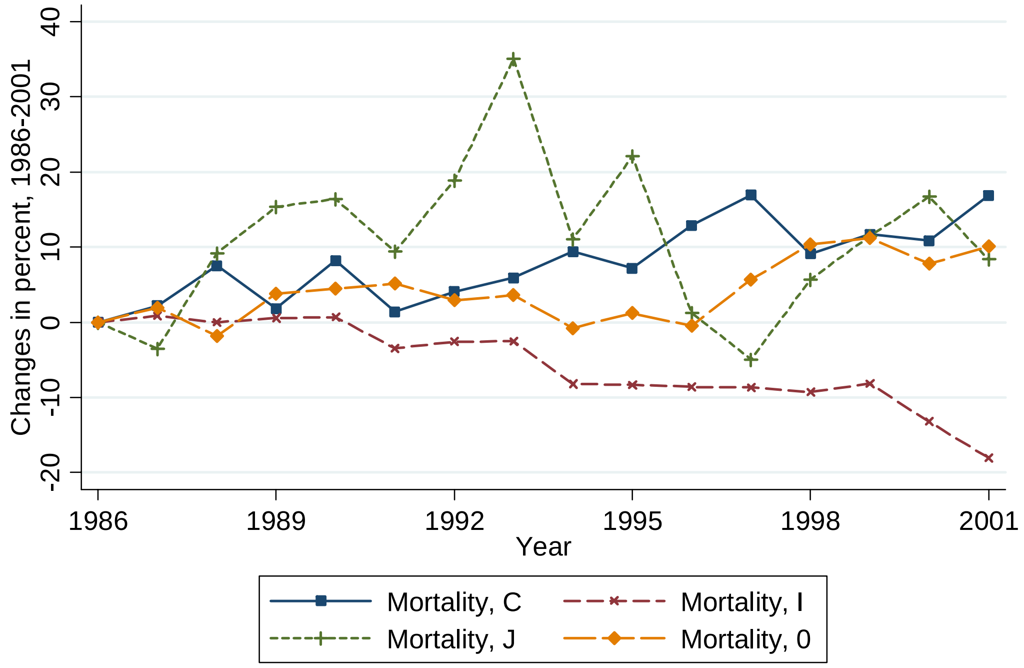
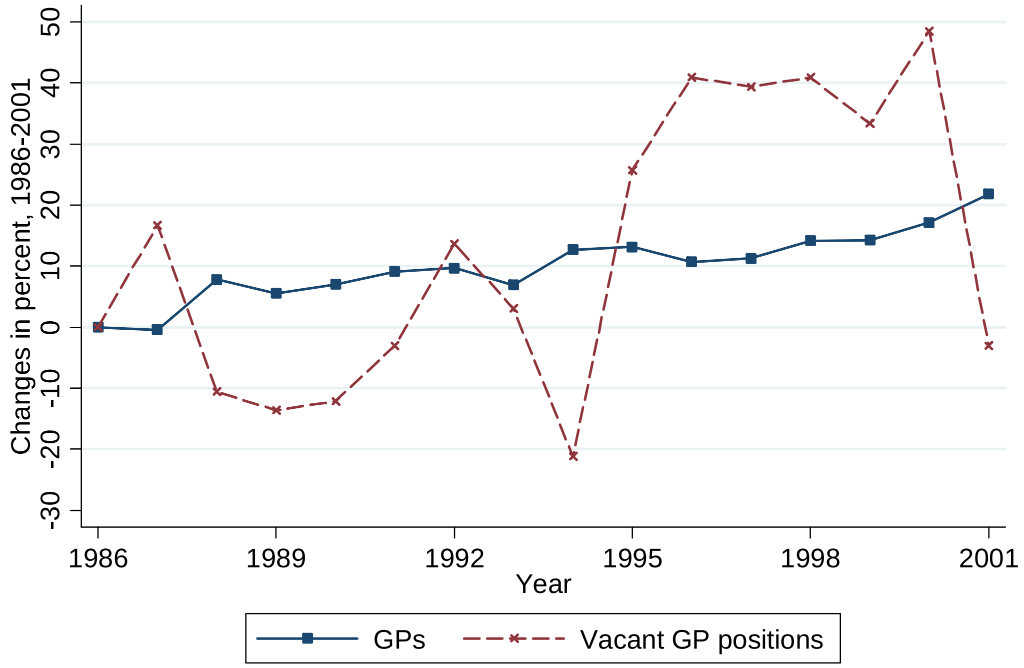


Figure 2. Changes in GPs and vacant GP positions



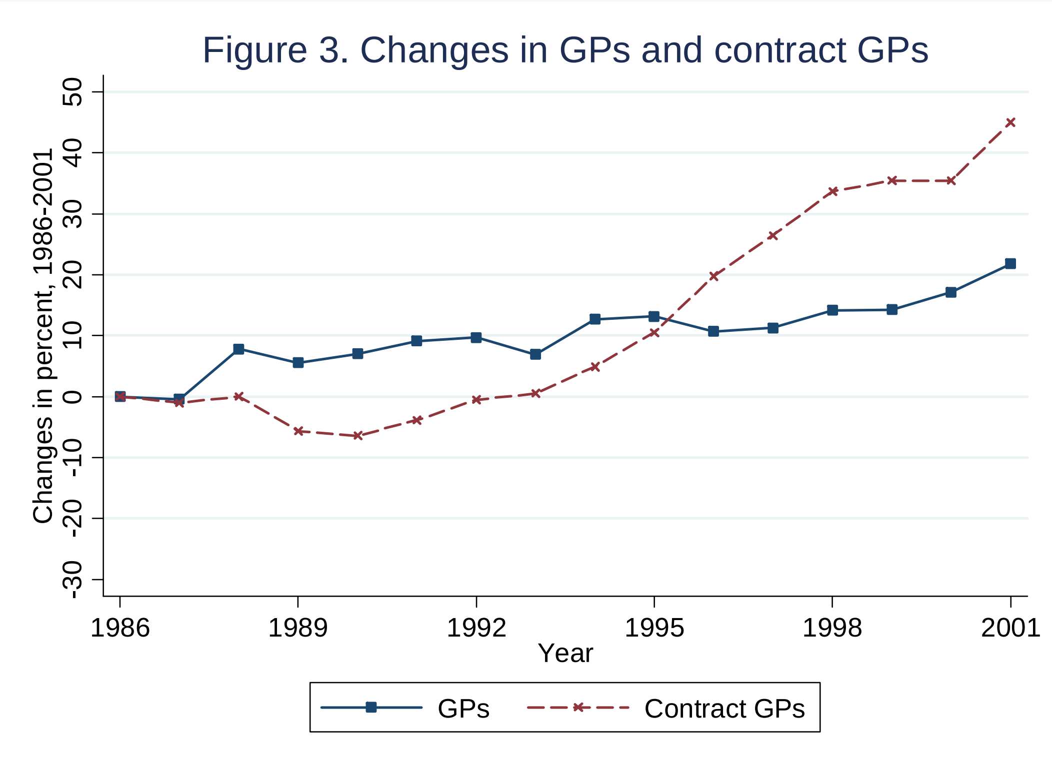


Figure 3. Changes in GPs and contract GPs
Changes in percent, 1986-2001
-30
-20
-10
0
10
20
30
40
50
1986
1989
1992
1995
1998
2001
Year
GPs
Contract GPs

Table 1. Variable descriptions.

Mortality ratio	Number of deaths per 1000 inhabitants
Mortality ratio C	Number of deaths due to malignant neoplasm (cancer) per 1000 inhabitants
Mortality ratio I	Number of deaths due to diseases of the circulatory system per 1000 inhabitants
Mortality ratio J	Number of deaths due to diseases of the respiratory system per 1000 inhabitants
Mortality ratio O	Number of deaths due to other causes per 1000 inhabitants
GPs	Number of GPs per 1000 inhabitants
Vacant GPs	Number of vacant GPs per 1000 inhabitants
Contract GPs	Number of employed GPs/number of contract GPs
Age67-79	Proportion of inhabitants older than 66 and younger than 80
Age80+	Proportion of inhabitants older than 80
High education	Percentage with high education in the municipality, inhabitants older than 20
Disability	Percentage of disabled in the municipality, inhabitants older than 20
Unemployment	Percentage of unemployed in the municipality, inhabitants older than 20
Divorce rate	Number of divorces per 1000 inhabitants, older than 20
Population	Number of inhabitants in the municipality

Table 2. Descriptive statistics by year.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Mortality ratio	11.151	11.261	11.371	11.461	11.636	11.200	11.352	11.569	10.997	11.094	10.967	11.138	11.134	11.330	11.003	10.845
	(2.875)	(2.883)	(2.974)	(2.960)	(2.942)	(3.004)	(2.950)	(2.893)	(2.851)	(2.794)	(2.880)	(2.760)	(2.880)	(2.920)	(2.841)	(2.955)
Mortality ratio C	2.283	2.333	2.455	2.324	2.470	2.315	2.376	2.418	2.498	2.447	2.577	2.670	2.491	2.550	2.531	2.669
	(0.947)	(1.005)	(1.021)	(0.898)	(1.050)	(0.977)	(0.972)	(0.996)	(1.023)	(0.973)	(0.956)	(1.020)	(0.961)	(0.933)	(0.968)	(1.099)
Mortality ratio I	5.583	5.631	5.583	5.614	5.621	5.389	5.439	5.442	5.124	5.119	5.103	5.098	5.064	5.127	4.844	4.575
	(1.869)	(1.859)	(1.876)	(1.968)	(1.784)	(1.882)	(1.817)	(1.852)	(1.763)	(1.720)	(1.762)	(1.707)	(1.844)	(1.939)	(1.827)	(1.779)
Mortality ratio J	0.969	0.935	1.058	1.118	1.128	1.060	1.152	1.309	1.076	1.183	0.981	0.921	1.024	1.080	1.131	1.050
	(0.733)	(0.592)	(0.756)	(0.782)	(0.736)	(0.730)	(0.795)	(0.830)	(0.767)	(0.725)	(0.650)	(0.587)	(0.731)	(0.694)	(0.720)	(0.736)
Mortality ratio O	2.317	2.362	2.275	2.405	2.420	2.436	2.385	2.400	2.299	2.345	2.306	2.449	2.556	2.576	2.497	2.550
	(1.078)	(1.101)	(0.998)	(1.066)	(1.066)	(1.061)	(1.128)	(1.072)	(1.027)	(1.054)	(1.064)	(1.051)	(1.078)	(1.177)	(1.109)	(1.071)
GPs	0.898	0.894	0.968	0.948	0.961	0.980	0.985	0.960	1.012	1.016	0.994	0.999	1.025	1.026	1.052	1.094
	(0.290)	(0.280)	(0.365)	(0.321)	(0.335)	(0.355)	(0.348)	(0.324)	(0.350)	(0.342)	(0.337)	(0.333)	(0.344)	(0.335)	(0.353)	(0.368)
Vacant GPs	0.066	0.077	0.059	0.057	0.058	0.064	0.075	0.068	0.052	0.083	0.093	0.092	0.093	0.088	0.098	0.064
	(0.168)	(0.190)	(0.150)	(0.159)	(0.170)	(0.164)	(0.160)	(0.158)	(0.144)	(0.183)	(0.201)	(0.184)	(0.205)	(0.197)	(0.214)	(0.169)
Contract GPs	0.389	0.385	0.389	0.367	0.364	0.374	0.387	0.391	0.408	0.430	0.466	0.492	0.520	0.527	0.527	0.564
	(0.403)	(0.404)	(0.393)	(0.390)	(0.385)	(0.389)	(0.386)	(0.387)	(0.394)	(0.395)	(0.405)	(0.405)	(0.397)	(0.392)	(0.385)	(0.369)
Age67-79	0.112	0.112	0.113	0.114	0.114	0.114	0.114	0.113	0.112	0.111	0.110	0.109	0.107	0.106	0.104	0.101
	(0.025)	(0.026)	(0.026)	(0.025)	(0.025)	(0.024)	(0.025)	(0.023)	(0.023)	(0.023)	(0.022)	(0.022)	(0.021)	(0.021)	(0.021)	(0.020)
Age80+	0.039	0.040	0.040	0.041	0.042	0.043	0.044	0.045	0.045	0.046	0.047	0.048	0.049	0.050	0.050	0.051
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)	(0.015)
High education	0.473	0.494	0.510	0.524	0.540	0.556	0.569	0.586	0.597	0.617	0.636	0.647	0.658	0.678	0.780	0.786
	(0.079)	(0.081)	(0.083)	(0.078)	(0.079)	(0.077)	(0.076)	(0.074)	(0.074)	(0.074)	(0.076)	(0.076)	(0.074)	(0.075)	(0.074)	(0.073)
Disability	0.076	0.080	0.083	0.088	0.090	0.091	0.091	0.089	0.087	0.089	0.090	0.093	0.095	0.100	0.102	0.104
	(0.026)	(0.028)	(0.029)	(0.029)	(0.031)	(0.030)	(0.037)	(0.030)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.028)	(0.028)	(0.028)
Unemployment	0.017	0.015	0.021	0.031	0.033	0.035	0.038	0.040	0.037	0.035	0.031	0.025	0.019	0.020	0.021	0.021
	(0.010)	(0.009)	(0.011)	(0.012)	(0.012)	(0.011)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.012)	(0.009)	(0.010)	(0.010)	(0.010)
Divorce rate	1.769	2.075	2.138	2.245	2.467	2.535	2.477	2.805	2.625	2.396	2.406	2.226	2.319	2.357	2.515	2.647
	(1.129)	(1.121)	(1.152)	(1.130)	(1.244)	(1.204)	(1.246)	(1.275)	(1.325)	(1.173)	(1.161)	(1.137)	(1.060)	(1.057)	(1.187)	(1.353)
Population	7.895	8.471	9.207	9.543	9.498	9.661	10.015	10.305	10.469	10.445	10.573	10.550	10.735	10.682	10.698	10.878
	(25.55)	(26.00)	(26.27)	(26.27)	(27.69)	(28.14)	(28.51)	(29.79)	(29.52)	(29.55)	(29.55)	(29.55)	(29.55)	(30.41)	(30.46)	(30.46)
Municipalities	339	333	346	363	373	366	391	365	384	392	398	400	393	401	407	406

Table 3. Explaining municipal mortality. Static and dynamic models.

	OLS	Fixed effect	GMM	GMM-SYS
Mortality ratio(-1)			0.056* (0.033)	0.105*** (0.041)
GPs	0.107 (0.088)	0.035 (0.143)	-0.479 (0.938)	-0.331 (0.478)
Vacant GPs	0.622*** (0.148)	0.676*** (0.161)	-0.591 (0.674)	-0.385 (0.518)
Contract GPs	0.042 (0.075)	-0.285** (0.136)	-0.832 (0.686)	-0.623* (0.349)
Age67-79	39.337*** (1.891)	24.961*** (3.635)	117.11*** (13.330)	29.450*** (4.445)
Age80+	81.591*** (3.057)	111.930*** (6.702)	385.50*** (25.654)	88.720*** (6.910)
High education	-3.020*** (0.509)	-3.151** (1.616)	-2.194 (3.611)	-3.088** (1.352)
Disability	14.328*** (1.050)	4.165* (2.445)	0.415 (3.597)	12.708*** (2.037)
Unemployment	6.658*** (2.536)	-2.506 (3.610)	-12.119 (7.087)	4.622 (4.493)
Divorce rate	0.111*** (0.023)	0.019 (0.023)	0.050 (0.036)	0.107*** (0.036)
Population	-0.021*** (0.001)	-0.021 (0.019)	0.002*** (0.001)	0.002*** (0.001)
Constant	3.445*** (0.410)	5.436*** (1.201)	-0.185 (0.182)	4.048*** (1.164)
Y1987	-0.005 (0.148)	0.029 (0.139)		
Y1988	-0.018 (0.148)	0.110 (0.149)		0.041 (0.166)
Y1989	-0.170 (0.153)	0.052 (0.172)	-0.191 (0.257)	-0.143 (0.173)
Y1990	-0.105 (0.157)	0.182 (0.193)	-0.050 (0.214)	-0.033 (0.179)
Y1991	-0.518*** (0.162)	-0.212 (0.214)	-0.468** (0.211)	-0.497** (0.196)
Y1992	-0.528*** (0.167)	0.229 (0.235)	-0.022 (0.204)	-0.419* (0.229)
Y1993	-0.235 (0.174)	0.052 (0.257)	0.137 (0.247)	-0.242 (0.227)
Y1994	-0.725*** (0.172)	-0.511** (0.265)	-0.494** (0.215)	-0.655*** (0.241)
Y1995	-0.607*** (0.175)	-0.425 (0.289)	0.085 (0.216)	-0.479* (0.258)
Y1996	-0.662*** (0.177)	-0.554* (0.311)	-0.096 (0.229)	-0.563** (0.255)
Y1997	-0.504*** (0.177)	-0.466 (0.325)	0.039 (0.246)	-0.394 (0.263)
Y1998	-0.509*** (0.179)	-0.518 (0.339)	-0.069 (0.217)	-0.418 (0.286)
Y1999	-0.357** (0.187)	-0.328 (0.371)	0.276 (0.223)	-0.273 (0.296)
Y2000	-0.322 (0.222)	-0.292 (0.524)	0.245 (0.393)	-0.306 (0.406)
Y2001	-0.470* (0.225)	-0.441 (0.532)	-0.072 (0.212)	-0.393 (0.429)
Observations	6052	6052	5183	5621
AR(1) test			-9.769	-9.379
(p-value)			0.000	0.000
AR(2) test			0.686	1.434
(p-value)			0.492	0.152
Sargan test			260.8	329.7
(p-value)			0.677	0.463

Results from two-step GMM and GMM-SYS estimator. ***: significant at the 1 percent level, **: significant at the 5 percent level, *: significant at the 10 percent level.

Table 4. Explaining municipal mortality. GMM-SYS models.

	Mortality C	Mortality I	Mortality J	Mortality O
Mortality ratio(-1)	0.101** (0.043)	0.112*** (0.042)	0.139*** (0.053)	0.123*** (0.049)
GPs	-0.243 (0.206)	-0.106 (0.396)	-0.136 (0.139)	-0.063 (0.228)
Vacant GPs	0.011 (0.242)	-0.058 (0.389)	-0.027 (0.163)	-0.046 (0.279)
Contract GPs	-0.400** (0.180)	-0.181 (0.283)	-0.068 (0.154)	-0.392** (0.176)
Age67-79	10.223*** (1.632)	13.547*** (2.576)	1.909 (1.421)	5.714*** (2.114)
Age80+	10.005*** (2.840)	46,576*** (4.937)	13.714*** (2.261)	14.163*** (3.572)
High education	0.206 (0.546)	-1.957** (0.944)	-0.295 (0.449)	-0.424 (0.603)
Disability	1.406** (0.665)	7.553*** (1.187)	0.376 (0.548)	3.299*** (1.055)
Unemployment	1.103 (1.845)	6.018* (3.279)	-0.174 (1.554)	-2.661 (2.096)
Divorce rate	0.028 (0.023)	0.042 (0.029)	0.020* (0.012)	0.029 (0.022)
Population	0.001** (0.000)	-0.000 (0.000)	0.001*** (0.000)	0.001*** (0.000)
Constant	0.636 (0.456)	1.996** (0.838)	0.271 (0.341)	1.003*** (0.527)
Y1988	0.122 (0.084)	-0.110 (0.133)	0.133** (0.055)	-0.107 (0.081)
Y1989	-0.097 (0.084)	-0.248* (0.131)	0.152** (0.065)	0.022 (0.092)
Y1990	0.042 (0.093)	-0.216 (0.140)	0.157** (0.065)	0.005 (0.091)
Y1991	-0.142 (0.098)	-0.480*** (0.145)	0.063 (0.067)	0.039 (0.100)
Y1992	-0.039 (0.111)	-0.464*** (0.159)	0.167** (0.079)	-0.049 (0.100)
Y1993	-0.033 (0.110)	-0.519*** (0.173)	0.292*** (0.081)	0.023 (0.111)
Y1994	0.055 (0.113)	-0.729*** (0.173)	0.089 (0.081)	-0.065 (0.115)
Y1995	0.023 (0.117)	-0.668*** (0.173)	0.198** (0.081)	-0.028 (0.117)
Y1996	0.158 (0.120)	-0.646*** (0.177)	-0.027 (0.083)	-0.043 (0.122)
Y1997	0.264** (0.117)	-0.658*** (0.185)	-0.047 (0.079)	0.069 (0.122)
Y1998	0.066 (0.125)	-0.673*** (0.196)	0.025 (0.084)	0.145 (0.123)
Y1999	0.152 (0.125)	-0.649*** (0.201)	0.076 (0.094)	0.179 (0.142)
Y2000	0.157 (0.175)	-0.732** (0.290)	0.133 (0.131)	0.113 (0.188)
Y2001	0.298* (0.172)	-0.969*** (0.297)	0.059 (0.131)	0.190 (0.192)
Observations	5621	5621	5621	5621
AR(1) test	-8.845	-9.374	-8.161	-8.277
(p-value)	0.000	0.000	0.000	0.000
AR(2) test	1.917	1.569	1.172	0.861
(p-value)	0.055	0.117	0.190	0.389
Sargan test	409.6	414.0	406.3	409.0
(p-value)	0.684	0.776	0.588	0.585

Results from two-step GMM-SYS estimator. ***: significant at the 1 percent level, **: significant at the 5 percent level, *: significant at the 10 percent level.

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