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THE EFFECT OF REIMBURSEMENT FEE CHANGES ON SERVICES PRODUCTION FOR LABORATORY TESTS IN NORWEGIAN PRIMARY HEALTH CARE

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The effect of reimbursement fee changes on service production for laboratory tests in Norwegian primary health care*

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Abstract

This paper examines how changes in reimbursement fees influence the service production of laboratory tests among Norwegian primary care physicians. The data represent a panel of 2,083 physicians paid on a fee-for-service basis for the period 2001–04. We construct a variable that measures the exogenous effect of changes in reimbursement fees on physician income. We measure service production by the number of laboratory tests per consultation, the relative change in the composition of laboratory tests, and the number of tests per consultation ordered from clinical laboratories. There are three main findings. First, physicians reduce the number of laboratory tests per consultation when fees decrease. Second, physicians change the composition of laboratory tests to tests that are more expensive when fees decrease. Finally, there is a spillover effect to the specialist health care sector because physicians who experience an income loss for tests analysed at the office laboratory order more tests from clinical laboratories. The results imply that fee regulation may be a simple means of controlling government expenditure. However, it is important to note the change in composition along with the potential spillover effects to other parts of the health care sector to obtain a complete picture of the influence of fee regulation on physician behaviour.

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1. Introduction

Fee-for-service is a common scheme of reimbursement for physicians in primary health care services. In contrast to fixed salaries, the physician's income then depends on the number of services provided, rather than the hours of work, thereby encouraging efficiency in service production (Sørensen and Grytten, 2003). However, a potential problem with fee-for-service schemes is cost control, and fee regulations constitute an often-used instrument for controlling physician income (Prendergast, 1999). An important issue is whether fee regulation is an efficient policy tool for influencing either the mix of services provided or total spending for physician services. In theory, fee regulation is a simple instrument for controlling costs; in practice, behavioural responses by physicians have shown this is not the case (Gruber et al., 1999).

The physician's response to fee regulation depends on the relative strengths of two effects.[1] In the event of a *fee reduction* for an item of treatment, the substitution effect pulls in the direction of a lower treatment volume as a physician wishes to perform fewer of the less profitable treatments relative to other activities (where fees may be unchanged). The income effect pulls in the direction of higher treatment volume because the physician attempts to compensate for the loss of income. The latter effect can be especially large if the treatment whose fee has been reduced accounts for a significant share of the physician's income (McGuire and Pauly, 1991). However, we cannot establish which effect dominates on theoretical grounds, leaving the provision of evidence to empirical investigation.

Several studies have investigated the relationship between fee changes and service production among physicians. The majority of these studies relate to specialized health services in the US, predominantly from the 1980s and 1990s (Rice, 1983; Schwartz et al.,

[1] The physician response to fee changes is commonly discussed in terms of income and substitution effects; see e.g. Rice and Labelle (1989) and McGuire and Pauly (1991). In this literature, physicians are commonly modelled as self-employed utility-maximizing agents. This is more general than the standard profit-maximizing model that considers the physician as a profit-maximizing multiproduct firm (Mitchell et al., 2001).

1981; Hurley et al., 1990; Escarce, 1993; Yip, 1998; Rice and Labelle, 1989).[2] Evidence on fee changes and physician behaviour is mixed. Mitchell et al. (2000; 2002) point out that many of the results from early studies are unreliable because of methodological problems, with most important shortcomings related to omitted variables, the use of unreliable price variables and explanatory variables with poor validity. Yip (1998) and Mitchell et al. (2000) appear to be the first contributions that distinguish between income and substitution effects, as earlier studies consider only the total effect of fee changes on the supply of services (Grytten et al., 2007). Distinguishing between these two effects is of some empirical importance as fee changes for one type of service may affect not only the volume for the service in question, but also the volume for other services whose fees may be unchanged (McGuire and Pauly, 1991). Yip (1998) analysed physician responses to Medicare fee reductions for coronary bypass graft (CABG) procedures in 1994, and found a strong negative income effect for the number of CABGs. She also found that fee reductions led to an increased number of CABGs in the private sector, indicating strong substitution effects. Mitchell et al. (2000) studied ophthalmologist and orthopaedic surgeon responses to fee reductions, and found a weak negative income effect for the number of cataract operations, while there was a positive income effect for the number of joint procedures, the latter suggesting that a reduction in fees does not lead to any compensatory change in behaviour. However, the fee reductions for both procedures were associated with increased volume for other services, suggesting a substitution effect. Keeler and Fok (1996) and Gruber et al. (1999) investigated the effect of fee changes on the number of caesarean deliveries. While the former found that a change in fees had a small effect on the number of caesarean deliveries, the latter found that an increase in fees led to a significant increase in the number of caesarean deliveries, suggesting a strong substitution effect.

[2] For a more complete list of studies, see Mitchell et al. (2000; 2002) or Grytten et al. (2007).

Few studies have investigated how changes in fees influence service production among primary care physicians. Hughes and Yule (1992) found that annual changes in fees over the period 1966–1989 did not influence the quantity of treatments related to maternity care and cervical cytology among physicians in the UK. Carlsen et al. (2003) and Grytten et al. (2007) found that changes in fees had no or little effect on the service level for laboratory tests among Norwegian physicians. However, the former study consists of a relatively small sample of physicians (n = 44) and the results should be interpreted with some caution, according to the authors. Both studies also use data from before the introduction of the list patient system in Norway in 2001. This reform introduced a larger element of competition among primary care physicians than previously found (Carlsen and Norheim, 2003). Importantly, physicians' responses to fee changes may differ from their responses before the introduction of the list patient system as the market's competitive structure influences behavioural responses to fee changes (Hadley and Reschovsky, 2006). Carlsen et al. (2003) and Grytten et al. (2007) mainly include control variables related to municipality characteristics in their analysis, omitting patient and (some) physician characteristics. According to Scott and Shiell (1997), these types of variables are important in explaining physician behaviour.

The aim of this study is to evaluate how changes in reimbursement fees influence service production for laboratory tests among primary care physicians in Norway. The majority of these physicians are paid on a fee-for-service basis, giving them an incentive to respond to fee changes. Fees are determined at the national level, and this makes the changes exogenous to the individual physician. Fee reductions implemented in 2004 for laboratory tests analysed at the physician's office laboratory constitute a natural experiment for addressing the following questions. First, do primary care physicians respond to fee reductions by increasing the number of laboratory tests in order to compensate for the loss of income? Second, do physicians alter their composition of laboratory analyses? Finally, is there a spillover effect from primary health care to specialist health care as physicians order more of their tests from external clinical laboratories? A panel data set covering reimbursement claims from 2,083 physicians paid on a fee-for-service basis over the period 2001–04 is employed for the empirical investigation. As the data include patient and physician characteristics, along with municipality characteristics, this study improves on previous studies of primary care physicians. We identify the income and substitution effects by exploring how the loss of income due to fee reductions affects service production by physicians, as measured by the number of laboratory tests per consultation, the relative change in the composition of laboratory tests, and the number of tests per consultation ordered from clinical laboratories.

The results show that the reduction in reimbursement fees has no income effect on the service level for laboratory tests analysed at the office laboratory. That is, physicians do not increase the number of tests analysed at the office laboratory to compensate for their income loss. However, there is evidence of a substitution effect, indicating that physicians change their composition of laboratory tests to tests that are more expensive when fees decrease. There is also a spillover of the fee reduction in primary health care into the specialist health care sector as physicians who experience a loss of income for tests analysed at the office laboratory order more of their laboratory tests from clinical laboratories. These findings suggest that income effects may not be as empirically important as the substitution and spillover effects. Failing to recognize these effects would then tend to understate the effects of fee regulation on physician behaviour and total spending on physician services.

The remaining part of the paper is organized as follows. Section 2 provides a brief description of the Norwegian primary health care sector. Section 3 presents the theoretical background on how reimbursement cuts may affect physicians’ service level for laboratory tests. The data and the empirical approach are presented in Section 4. In Section 5, the empirical findings are discussed, while the final section offers some concluding remarks.

2. Institutional background

Municipalities in Norway (431 in 2006) are responsible for the organization of primary health care services, including primary care physician services. Two types of physicians, community physicians and contract physicians, mainly provide these services.[3] Both types of physicians work separately from the hospital service and are intended to provide the first contact between patients and the health care service. Community physicians represent about 14% of all primary care physicians (Statistics Norway, 2008). They are employed by a municipality and are paid according to a preset salary scheme for normal working hours.

Contract physicians represent about 76% of primary physicians (Statistics Norway, 2008). They are self-employed and have a contract with the municipality to cover some of their expenses (personnel, equipment, etc.). In addition, contract physicians obtain income from patient co-payments and receive payments from the National Insurance Agency (NIA) based on a fixed fee reimbursement scheme. The sizes of the municipality grant, co-payments, and reimbursement fees are regulated by a 'normal tariff', which is an annual agreement negotiated between the Norwegian Medical Association and the Ministry of Government Administration. The local government grant constitutes about 30% of the contract physician's gross income, while co-payments and reimbursement fees, respectively, constitute the remaining 30% and 40% of gross income (Grytten et al., 2007). Community and contract physicians both use the same national reimbursement scheme. However, while contract physicians receive their income directly from the NIA, income generated by community

[3] In addition, there are independent physicians (8%) and junior physicians (2%). Independent physicians do not have a contract with a municipality and tend to be located in major cities (Statistics Norway, 2008). Junior physicians are medical students who have completed their studies, but are not fully registered, needing to work for one year under the supervision of a municipality and a hospital before they are fully registered (Grytten et al., 2007). Junior physicians mainly find employment in small municipalities (Statistics Norway, 2008).

physicians is paid to the municipalities. Hence, only contract physicians have an income motive or incentive to respond to changes in reimbursement fees.

In Norway, primary health care physicians are able to analyse tests at their office laboratory and/or order tests from external clinical laboratories. The physicians are reimbursed by the NIA according to the type of test analysed at the office laboratory. Tests ordered from clinical laboratories are reimbursed according to the type of sample and the number of samples shipped by the physician to the laboratory.[4] About 1,900 (99%) physician offices have laboratory facilities and 24% of the reimbursement claims (including co-payments) to the NIA are related to the use of laboratory services (Fauli and Thue, 2005; Nossen, 2007). Laboratory tests are highly used relative to other European countries, mainly because of geographical factors (distance to hospital, etc.) and economic incentives (Fauli and Thue, 2005). Fee changes for tests analysed at the office laboratory may therefore have a considerable effect on physician income.

Table 1 details changes in the reimbursement fees for all laboratory tests (mean) and for the three tests most frequently analysed at the office laboratory among primary care physicians for the period 2001–04. The fees for all laboratory tests have, on average, increased each year. However, in July 2004, they were reduced by (on average) 29%. Some fees were reduced only moderately, and others more heavily. For example, the fees for immunology and PT–INR (Prothrombin Time–International Normalized Ratio) tests fell by 58% and 33%, respectively.[5]

[Table 1 about here]

[4] In this case, the fees for clinical laboratories that are part of the specialized health care services (and often attached to a hospital) are reimbursed by the NIA according to the type of test ordered (following a tariff scale).

[5] The objective of the fee reductions was not to change the service level or the mix of laboratory tests provided at the physician's office. Rather, the reductions were a monetary transfer from reimbursement fees to the government grant, as well as an increase in the use of co-payments. The size of the fee reduction depended on the total national volume of the specific laboratory test and costs (Norwegian Medical Association, 2004).

Before the fee changes in 2004, patients paid a co-payment (code: 701a) only when laboratory tests were analysed outside the physician's office laboratory (i.e., the blood sample was sent to an external clinical laboratory). After July 2004, patients had to pay a co-payment each time a test was analysed. However, the co-payment was paid only once per consultation.[6] Consequently, the impact of the fee reductions on income varied among physicians according to practice style. In particular, physicians who tended to analyse several tests at the office laboratory during a consultation experienced a drop in income, as the additional co-payment would not cover the fee reductions. Physicians who often combined tests analysed at the office laboratory with tests ordered from clinical laboratories also experienced a drop in income, because they could claim the co-payment only once per consultation. On the other hand, physicians who tended to analyse one laboratory test during a consultation might benefit from the change, provided the co-payment made up for the fee reduction. However, most consultations involving laboratory tests include more than just one test. Hence, the majority of physicians experienced a drop in income.

3. Theoretical background

The theoretical framework underlying the empirical analysis is based on the McGuire and Pauly (1991) model of physician response to fee changes in a single-payer market.[7] This model views the physician as a utility-maximizing agent, where the physician's utility is a function increasing in income and leisure and reducing in effort. Standard profit-maximizing theory predicts that physicians will respond to fee reductions by reducing the service level for the affected procedure (Mitchell et al., 2002). However, the McGuire and Pauly model

[6] To clarify, the patient pays the co-payment and it is not reimbursed by the NIA. However, the size of the payment is centrally determined in the 'normal tariff' and is listed alongside other fees in the tariff scale. The remainder of the fees relating to laboratory tests are reimbursed by the NIA.

[7] We outline only the main assumptions and results from the McGuire and Pauly model here. For details and comparative statics, see McGuire and Pauly (1991) and McGuire (2000).

postulates that a physician may respond to fee reductions by increasing the service level to compensate for the loss of income. Hence, the model differs from profit-maximizing theory by accommodating both benchmark cases of profit maximization and target income, subject to time constraints, effort, and available income.

In formal terms, the single-payer model with a physician providing two tests (1 and 2) analysed at the office laboratory can be written as $U = U(I, L, E_1, E_2)$, where the physician maximizes U by deciding how much effort (E_1, E_2) to expend during a consultation, subject to time/leisure ($L = 24 - X_1(E_1)h_1 - X_2(E_2)h_2$) and income ($I = X_1(E_1)m_1 + X_2(E_2)m_2$). E_1 and E_2 are effort related to analysing tests at the office laboratory, I is total income, L is leisure, and h_1 and h_2 are time per unit provided. The numbers of laboratory tests 1 and 2 analysed at the office laboratory are represented by X_1 and X_2. The fee levels for the laboratory tests affect the physician's income through the profit margin. The profit margins, defined as fees minus costs (laboratory equipment, personnel, etc.), for the two laboratory tests at the office are m_1 and m_2, respectively. The physician's utility U increases in net income (I) and leisure (L), but decreases in effort (E): $U_I > 0$; $U_L > 0$; $U_E < 0$; $U_{II} < 0$; $U_{LL} < 0$; $U_{EE} < 0$; $U_{LE} = U_{IL} = U_{IE} = 0$. The choice variable in the utility maximization is effort, which yields the optimal amount of effort (E_1*, E_2*), where the service volume is increasing in effort.[8]

The expected change in the quantity of X_1 and X_2 due to a fee reduction for, say laboratory test 1 (m_1 reduced), is theoretically ambiguous because of two counteracting effects: an income effect, which depends on the impact of the fee change on the physician's income, and a substitution effect, which depends on the profit margin for alternative services. McGuire and Pauly (1991) show that the income effect is the key determinant of the physician

[8] For most diagnoses, a 'right treatment' does not exist; rather, there is an interval for what is the medically acceptable treatment (Enthoven, 1980). By increasing effort, the physician may start ordering more or different laboratory tests within this interval. Efforts outside the interval could be regarded as fraudulent.

response to fee changes.[9] In this context, two polar cases have received attention in the literature: the profit-maximization case with no income effect, and the target income case with a strong income effect.[10] If there are no income effects, then the profit-maximization hypothesis implies that the fee cut for laboratory test 1 will lead to a decrease in X_1 and an increase in X_2 (where the decrease in X_1 is greater than the increase in X_2). If this is the case, the substitution effect dominates the income effect, and the service volume of tests analysed at the office laboratory will fall. By contrast, with strong income effects, the physician may increase both X_1 and X_2 to compensate for the income loss (i.e., such as $I_t = I_{t+1}$). The income effect then dominates the substitution effect, and the service volume of tests analysed at the office laboratory will increase. Actual physician behaviour is likely to fall between these two cases. The effect of the fee reduction for laboratory test 1 on effort for test 1 is ambiguous, depending on the substitution and the income effects, but unambiguous for test 2—effort should increase because both effects work in the same direction (McGuire, 2000). Ultimately, determining the relative strength of the income and the substitution effects remains an empirical question.

An alternative for the physician to analysing tests at the office laboratory is to order them from external clinical laboratories. In this sense, the existence of clinical laboratories provides an avenue for reducing the loss of income due to fee cuts for tests analysed at the office laboratory. Following Mitchell et al. (2002) and Yip (1998), we can use the same framework to analyse *spillover* effects—how a decline in fees for tests analysed at the office laboratory affects the service volume for tests ordered from clinical laboratories. Letting X_2 in our model represent tests ordered from clinical laboratories, reductions in fees (m_1) for tests analysed at the office laboratory will not increase the number of tests from clinical

[9] McGuire and Pauly (1991) worked out comparative statics for cases where only the income effect matters (target income theory) and when the income effect does not matter at all (profit-maximizing theory).
[10] In the literature, profit maximization is defined as the case where $U_{II} \rightarrow 0$. The target income hypothesis is where $U_{II} \rightarrow -\infty$ (McGuire, 2000).

laboratories if there are no income effects (Mitchell et al., 2002). However, the presence of a strong income effect will lead to an increase in the number of laboratory tests ordered from clinical laboratories (the spillover effect), instead of analysing the same tests at the office laboratory, for example.[11] Changes in the marginal utility of leisure may also result in spillover effects. If the fee cuts reduce the volume of X_1, then the amount of time performing tests at the office laboratory decreases and the marginal utility of leisure increases. In turn, this gives the physician an incentive to increase X_2 to restore the optimum. If this is the case, then the fee cuts in 2004 for tests analysed at the office laboratory may have resulted in an increase in tests ordered from clinical laboratories.

As the physician's income from laboratory tests constitutes a large part of total practice income, and because the marginal cost is low in relation to the fee, McGuire and Pauly (1991) argue that the income effect should dominate the substitution effect. Conversely, several factors influence the physician effort (E_1 and E_2), including medical guidelines, the competitive structure in the market, and the payment rules or mechanisms for limiting fee abuse (Hadley and Reschovsky, 2006). For example, in Norway, the NIA undertakes regular controls of physician practices that probably subdue any extreme behavioural responses to fee changes. We outline the empirical model below used to test the above hypotheses.

4. Data and empirical model

Data on individual physicians were obtained from the NIA. The data provided are primarily used by the NIA for administrative purposes and for monitoring physician activities, treatment patterns, and levels of expenses (Grytten et al., 2007). All primary care physicians (both contract and community) in Norway must register their activities, and each year data are collected for a sample of physicians, mainly concerning activities during September and

[11] In this case, one would expect that the tests regarded as unprofitable would be from clinical laboratories, while the profitable tests are those still analysed by the physician at the office laboratory.

October. However, the data are somewhat limited because only electronic reimbursement claims are registered, thereby excluding paper-based reimbursement claims. However, the proportion of physicians using electronic patient journals is high.[12] Hence, the data are expected to be representative of the population of primary care physicians in Norway.

We constructed a panel data set comprising 2,083 contract physicians observed for the years 2001 to 2004.[13] Each physician in the panel is observed during September and October in each year except 2004, where we observe the physicians in October, November, and December. Because we are interested in evaluating yearly changes in service production, the observations have been aggregated into one-year observations for the 2,083 physicians. The year 2001 is the base year for constructing the lagged independent variable (Eq. 1). We therefore exclude observations for 2001 from the final sample.

Following Mitchell et al. (2000), the independent variable used to estimate the income effect on service production is constructed in the following manner. The income of each physician from all laboratory services provided in year *t–1* is calculated. We then calculate what the income would be from laboratory services in year *t* with the same service level as in year *t–1*, but with the reimbursement fees of year *t*. The difference between the actual and predicted income is interpreted as the component of change in total physician income from laboratory services due to changes in the national fee schedule (Grytten et al., 2007). Formally, this can be written as:

$$I_{it} = \sum_{j=1}^{J} L_{jit-1} * \left(R_{jt} - R_{jt-1}\right), \tag{1}$$

[12] About 90% of primary care physicians used electronic patient journals in 2000 (Ellingson and Monteiro, 2003). This proportion is higher today.
[13] In addition, 160 community physicians in the data set serve as a control group in the analysis.

where L_{jit} is the number of laboratory tests of type j provided by physician i in year t, and R_{jt} is the reimbursement fee for laboratory test j in year t. I_{it} is physician specific because relative fees vary over time and laboratory services vary across physicians. Further, as I_{it} is constructed from data on lagged quantities and exogenous fees, I_{it} does not depend on L_{jit} and is therefore exogenous to physician responses to fee changes (Mitchell et al., 2002).

Using income change I_{it} as our key explanatory variable, we analyse the effect of fee changes on the following dependent variables: (*i*) the number of laboratory tests analysed at the office laboratory per consultation, (*ii*) the relative change in service composition for tests analysed at the office laboratory, and (*iii*) the number of tests ordered from clinical laboratories per consultation. The three dependent variables measure the physicians' service production for laboratory tests. The construction and interpretation of the dependent variables are outlined below.

The number of laboratory tests per consultation for physician i in year t measures the physician's utilization of tests from the office laboratory and can be written as:

$$Y_{it}^{i} = \sum_{j=1}^{J} L_{jit} \Big/ C_{it} \ , \qquad (2)$$

where C_{it} is the number of consultations provided by physician i in year t. To track changes in the composition of services provided due to fee changes, we construct a dependent variable that measures each physician's relative change in service composition for year t and $t\text{–}1$. Average reimbursement for all laboratory services in year t and $t\text{–}1$ is calculated using reimbursement fees in year $t\text{–}1$ for each physician. Formally, this can be written as:[14]

[14] S_{it} parallels the Laspeyres quantity index (subtracted from 1) used to compare average consumption in year t with consumption in a base period (in this case $t\text{–}1$). See, for example, Varian (1996, p. 130).

$$Y_{it}^{ii} = \left(\frac{\sum_{j=1}^{J} L_{jit} * R_{t-1}}{\sum_{j=1}^{J} L_{ijt}} - \frac{\sum_{j=1}^{J} L_{jit-1} * R_{t-1}}{\sum_{j=1}^{J} L_{ijt-1}} \right) \Bigg/ \left(\frac{\sum_{j=1}^{J} L_{jit-1} * R_{t-1}}{\sum_{j=1}^{J} L_{ijt-1}} \right). \qquad (3)$$

If $Y_{it}^{ii} = 0$, the physician has not changed the composition of laboratory services between year $t-1$ and t. If $Y_{it}^{ii} > 0$, the physician has changed the composition of services at the office, providing a greater number (relative to the total number of services) of expensive laboratory services in year t than in year $t-1$. The number of tests ordered from clinical laboratories per consultation for physician i in year t measures the physicians' use of tests from clinical laboratories and can be written as:

$$Y_{it}^{i} = \sum_{k=1}^{K} L_{kit} \Big/ C_{it} \ , \qquad (4)$$

where L_{kit} is the number of laboratory tests of type k ordered from clinical laboratories by physician i in year t.

The following fixed-effects model is estimated for *each* dependent variable to account for unobserved but time-invariant physician characteristics:[15]

$$Y_{it}^{*} = \beta_1 I_{it} + \beta_2 Z_{it} + \beta_3 X_{it} + \alpha_i + \varepsilon_{it} , \qquad (5)$$

where β_1 captures the effect of fee change on service production. The variable α_i is a physician-specific effect included to take account for time-constant effects that are physician specific. Grytten and Sørensen (2003) showed that there are large variations in practice profile, but that these variations are stable over time. ε_{it} is an identically and independently

[15] An asterisk indicates the dependent variables (*i*), (*ii*) and (*iii*).

distributed error term and Z_{it} is a vector of control variables related to patient composition and physician characteristics. These variables are constructed from the data provided by the NIA. X_{it} is a vector of control variables at the municipality level that may influence the physicians' service production of laboratory tests. These variables are from Statistics Norway.[16] All variables included in the model are defined in Table 2.

[Table 2 about here]

A priori, the sign for our key explanatory variable I_{it} (Eq. 1) is undetermined in the three regression models (Eq. 5). However, from the theory in McGuire and Pauly (1991), some expectations can be postulated for these models. First, the physicians may increase the number of tests analysed at the office laboratory (Y_{it}^{i}) in response to fee reductions. If this is the case, then the McGuire and Pauly model indicates a strong income effect, and the estimated coefficient for the income change variable is expected to be negative. Second, the physicians may respond to fee reductions by substituting away from tests with a low profit margin (or with a high price reduction) to tests with a higher profit margin (or a low price reduction). If this is the case, the income change variable is expected to have a negative coefficient when the physician's average reimbursement claim to the NIA increases (Y_{it}^{ii}), thereby indicating a substitution effect. Lastly, when fees are reduced for tests analysed at the office laboratory, physicians may also substitute away from analysing tests at the office laboratory to ordering tests from clinical laboratories (Y_{it}^{iii}), because the profit margin for tests at the office is lower than that for tests ordered from clinical laboratories. The direction of this (cross-price) effect depends on the relative size of the income effect (McGuire and Pauly,

[16] We measure both salaries and rents at the economic region level, as these data are not available at the municipal level. An economic region consists of a town or a population centre that makes up a central point, surrounded by smaller municipalities. Norway comprises 89 economic regions, and we link the physicians' practice municipalities to these economic regions.

1991). We do not measure cross-price effects directly; however, this spillover effect is made evident by using the potential change in income as a measure of the physician's volume response (Yip, 1998; Mitchell et al., 2002). If so, then the income change variable is expected to have a negative coefficient. We now turn to the estimation results.

5. Results

Table 3 reports the level and percentage changes in consultations and laboratory tests, and the number of laboratory tests per consultation for the period 2001–04, excluding laboratory tests ordered from clinical laboratories. The average number of consultations per month increased over the whole period, implying that the number of laboratory tests should also increase.[17] However, while the volume of laboratory tests increased by 6.8% between 2002 and 2003, there was no growth between 2003 and 2004. Hence, the mean number of laboratory tests per consultation fell between 2003 and 2004. This observation is consistent with the profit-maximization hypothesis, i.e., lower fees result in a decreased volume of laboratory tests.

[Table 3 about here]

Table 4 provides descriptive statistics of the variables used in the regression model, including the income change variable (Eq. 1) and the service-mix variable (Eq. 3). In 2002 and 2003, physicians had a small potential monthly gain in income, while in 2004 the fee reductions led to a large potential monthly loss of income of about NOK 2,400 (€300). The relative change in the physicians' service mix was positive during the whole period, indicating that each year physicians provide a greater number of expensive laboratory services than in the previous year.

[17] It is reasonable to expect that the number of services provided during a physician visit increases as the number of consultations per month increases, unless it concerns consultations demanding no services beyond simply consulting with the physician (a somewhat preposterous explanation).

[Table 4 about here]

About 7% of physicians have expensive/advanced laboratory equipment (cell-counter and dry-chemistry machines). The proportion using advanced laboratory equipment decreased during the sample period with a large fall in 2004. This may indicate that over time laboratory tests analysed by these types of machines have become more unprofitable. The proportion of physicians that are specialists in general medicine has increased. This is of no surprise because economic incentives in the reimbursement scheme stimulate physicians to engage in further training.[18] Overall, the majority of the control variables are stable over time. Exceptions include the rental prices and wages, which increase each year (as expected). The descriptive statistics indicate that there have not been any considerable changes in the characteristics of physicians, patients, or communities over the period that should drive changes in the dependent variable.

5.1 Tests analysed at the office laboratory

Table 5 reports the coefficient estimates for (*i*) the number of laboratory tests analysed at the office laboratory, and (*ii*) the relative change in the service composition for tests analysed at the office laboratory. To assess to what degree physician, patient, and community characteristics affect our key explanatory variable, we estimate Eq. 5 stepwise by including groups of explanatory variables one at a time. Model 1 includes no control variables, while Model 2 includes physician and patient characteristics as control variables. Model 3 is the full model including all the control variables outlined earlier.

[18] Physicians that are specialists in general medicine receive an extra payment on top of the normal consultation fee; hence, all contract physicians have an incentive to undertake further training to become a specialist.

[Table 5 about here]

Examining (*i*) the number of tests analysed at the office laboratory per consultation, we see that the coefficient for the income variable is positive and highly significant, irrespective of the model specification (Models 1–3). The estimated coefficient is twice the size when municipality characteristics are included as controls in Model 3, indicating that control variables at the municipality level are important in explaining physician behaviour. Taken together, the results suggest that physicians who face a decline in income reduce the volume of laboratory tests analysed at the office. The estimated coefficient also tells us that physicians use less time analysing tests at the office laboratory, as theoretically expected. However, even if the coefficient is highly significant, the magnitude is small. In Model 3, the number of tests per consultation is reduced by 3% per NOK 1,000 (€125) income loss, equivalent to a reduction of five laboratory tests per month. Examining the interaction term 'Income*community physician', we can see that the estimated coefficient is positive in Model 3 although insignificant, suggesting that community physician behaviour does not differ from contract physicians.

The other variables included in the model have the predicted signs. A physician who has invested in expensive laboratory equipment has a relatively higher volume of laboratory services. Physicians that are part of a group practice analyse fewer laboratory tests than solo practice physicians do. Both the wage and the rent variables have the expected positive signs. As the input prices increase, physicians perform more laboratory services. Another observation is that when unemployment increases, the number of tests increases. Overall, the key results are robust to alternative specifications.

Examining (*ii*) the relative change in the service mix, we find that the estimated coefficient for the income variable is negative and highly significant in all three models. This implies that physicians meet the fee reductions by changing the composition of laboratory tests to tests that are more expensive. The average reimbursement claim for laboratory tests increases by 21% per NOK 1,000 (€125) income loss. Examining the interaction term ‘Income*community physician’, we can see that the estimated coefficient is positive and significant in Models 1 and 2, but becomes insignificant in Model 3, suggesting that the community physicians’ behaviour here also does not differ from that of the contract physicians.

The control variables included in Models 2 and 3 are generally insignificant. The number of patients older than 68 years has a positive effect on service composition, while the physician population has a negative effect on service composition. The former is related to the fact that the elderly have poorer health and greater need for more advanced (read expensive) laboratory tests. The latter may be explained by the fact that when competition increases, it has a positive effect on the number of tests analysed at the office. If this relates to the use of simpler tests (read less expensive), their increased use contributes to a fall in average reimbursement claims to the NIA.

5.2 Tests ordered from external clinical laboratories

Physicians can either analyse laboratory tests in their own laboratory or order them from a clinical laboratory. The theoretical model predicts that if the margin for analysing a specific test at the physician’s office is less than the margin for sending it away (after the fee is reduced for tests analysed at the physician’s office laboratory), the physician may start ordering that specific type of laboratory test from clinical laboratories in their place. In this way, physicians can limit their income loss due to the reduction in fees.

There are two challenges related to analysing the number of tests ordered from clinical laboratories. First, it is not possible to identify uniquely which type of laboratory test is ordered from the clinical laboratory during a consultation. Second, it is also not possible to identify uniquely in 2004 consultations which clinical laboratories tests are ordered from. This is because only four different fees exist for ordering tests from clinical laboratories. The first is the co-payment for the taking and shipment of a blood sample, while the last three are fees (reimbursed by the NIA) for the additional shipment of blood and other types of samples. These fees are used independently of the type of laboratory test that is ordered. In addition, before 2004, patients paid a co-payment only when laboratory tests were analysed outside the physician's office (i.e., the blood sample was sent to a clinical laboratory). After July 2004, patients had to pay each time a blood sample was taken in the office.[19]

Because there is a natural increase in co-payments due to the new regulations in 2004, including the co-payments in the analysis of laboratory tests ordered from clinical laboratories will presumably bias the results. To cope with this challenge, three different dependent variables are constructed. These are: (1) the mean number of laboratory analyses per consultation sent to clinical laboratories, including co-payments; (2) the mean number of laboratory analyses per consultation sent to clinical laboratories, excluding co-payments; and (3) the mean number of laboratory analyses per consultation, including 'dummy 'co-payments for each consultation in 2001–03 where tests were analysed at the office laboratory (assuming that the change in the reimbursement scheme in 2004 was already in force). Table 6 reports the average change in the number of laboratory tests per consultation from clinical laboratories during the period 2001–04 for the three dependent variables.

[Table 6 about here]

[19] Assume that a physician needs to do an INR test (code 710) for a patient. He/she can then choose between two scenarios: (a) order the test from a clinical laboratory, or (b) analyse the test at the office laboratory. Before 2004, physicians could only claim the co-payment (code 701a) in scenario (a). Since 2004, they can also claim the co-payment in scenario (b). This gives us the following coding for the consultations: before 2004, (a) 701a, (b) 710; after 2004, (a) 701a, (b) 701a + 710. It is not possible to separate the two scenarios, because scenario (b) can now indicate two different things: (1) that the physician analyses an INR test at the office laboratory, or (2) he/she analyses an INR test at the office laboratory and orders a test from a clinical laboratory.

Each of the dependent variables constructed has its own weaknesses. In variable construction (1), we see that between 2002 and 2003 the volume of laboratory analyses was almost constant, while between 2003 and 2004 growth was 62%. The latter can be explained as a 'natural increase' because of the change in the regulation of co-payments in 2004. Any income effect will with some certainty be overstated when using this dependent variable. In variable construction (2), which excludes co-payments, there is a decrease in the number of laboratory tests per consultation each year, except from 2001 to 2002. This indicates that the observed growth in variable (1) is largely driven by co-payments. However, the exclusion of co-payments will underestimate possible growth. This implies that the potential income effect, if any, will be underestimated. Variable construction (3) shows growth each year more in line with what would be 'expected'. However, including a co-payment dummy variable provides room for potential measurement errors.

Table 7 reports the results for (*iii*) tests ordered from external clinical laboratories using the three dependent variables. The analysis is undertaken using a fixed-effects model with the same assumptions outlined earlier.[20]

[Table 7 about here]

If a fee reduction for tests analysed at the office results in substantial income losses, physicians may attempt to offset the income losses by ordering more tests from clinical laboratories. In the literature, this is known as the 'spillover effect'.[21] If such behaviour exists, then the estimated coefficient for the income variable should have a negative sign (Yip, 1998;

[20] One possibility would be to include one of the three dependent variables as a control variable in the analysis of tests analysed at the office laboratory. However, this would mean adding an endogenous variable to the model. Hence, we divide the analysis between tests analysed at the office and the clinical laboratory.
[21] See e.g. Yip (1998) and Mitchell et al. (2000; 2002).

Mitchell et al., 2002). Regardless of which dependent variable and specification we use, the estimated coefficient is negative and highly significant. As expected, the coefficient is largest using variable construction (1). However, this variable is upwardly biased. Excluding co-payments from dependent variable (2) makes the size of the estimated coefficient smaller. However, this variable is downwardly biased. Surprisingly, even if there is a decrease in the total service volume, the coefficient is still negative and highly significant. The third variable construction (3) yields the same results, and together with (2) can be regarded as providing the upper and lower limit. Taken together, the results indicate that physicians who experience a substantial drop in income for laboratory tests analysed at the office increase the number of tests ordered from clinical laboratories by between 1.7% and 8.2% per NOK 1,000 income loss. It is evident that it has become more profitable to order tests from clinical laboratories since the fee change because of the change in relative prices for the two types of laboratory services (office laboratory vs clinical laboratory). The interactive term ‘Income*community physician’ also suggests that the behaviour of community physicians does not differ from that of contract physicians.

5.3 Specification and robustness tests

Several specification and robustness tests are run to further verify the results. First, the service-mix variable (Eq. 3) was constructed with reimbursement fees in year t instead of $t–1$. There is a potential measurement error in this variable because a laboratory test that was below the average payment from the NIA in year $t–1$ may be above it in year t (or vice versa).[22] However, all of the main conclusions remain unaltered when estimating the models with this version of the service-mix variable. We also multiplied the two service-mix variables and took their square root. This specification resembles a Fisher quantity index as

[22] S_{it} then parallels a Paasche quantity index (subtracted from 1). See Varian (1996, p. 130).

the geometric mean of the Laspeyres and Paasche quantity indexes (Dumagan, 2002). However, running the regressions with this variable did not change the main result—when fees fall, physicians provide a greater number of expensive laboratory tests.

Second, Models 2 and 3 for laboratory services provided at the office were estimated for community physicians alone (see Table A1 in the Appendix). Community physicians have a fixed salary, and therefore have no incentive to respond to fee changes. For (*i*) the number of tests analysed at the office and (*ii*) the relative change in service mix, we do not find any significant results for the income variable. Compared with the results in Tables 5 and 7, this may be an indication that the number of community physicians (n = 162) is too small to give any significant results in the estimations. Hence, the 'Income*community physician' interaction term should be interpreted with caution. On the other hand, the income variable is positive and significant for ordering variables from clinical laboratories (using variable construction 3). This suggests that community physicians may have some compensatory behaviour related to budget commitments towards the community.

Finally, as it is not plausible to say that the three equations are independent, the error term in each equation could be correlated. Following Yip (1998), we take the first difference of each variable. We then estimate the three dependent variables using seemingly unrelated regression (SUR) in order to account for correlations across equations to see whether this changes the key results (see Table A2 in the Appendix).[23] The estimated coefficient becomes slightly larger for (*i*) the number of tests analysed at the office laboratory and (*ii*) the service mix, while the estimated coefficients for (*iii*) the number of tests ordered from clinical laboratories became slightly smaller for all three specifications. Even though there are some small changes in the coefficients, none of the main results changes using this approach.

[23] See Greene (2000) for a discussion of SUR.

6. Concluding remarks

Changes in the reimbursement fees for health care services can add up to profound changes in physician income. Economic theory predicts that fee changes may cause physicians to alter the service volume as well as the mix of services provided. Fee changes may also result in spillover effects that cause physicians to change the service level of other health care services. In this study, we examined how a change in reimbursement fees affects the number and composition of laboratory tests performed by Norwegian primary care physicians. Following Yip (1998) and Mitchell at al. (2000), we constructed a separate variable that measures the exogenous effect of changes in reimbursement fees on physician income. The estimated coefficient of this variable on the service level is interpreted as an income effect. In addition, we constructed a separate variable that measures the relative change in service mix. We can interpret the estimated coefficient of the income variable on the service mix as the substitution effect.

There are three main findings. First, there is a positive and small income effect for the number of tests analysed at the physician's office laboratory, suggesting that physicians that experience a loss of income reduce their service volume. However, while the estimated coefficient is highly significant, its magnitude is small. This finding suggests that physicians behave more like profit maximizers and do not pursue a target income strategy. Second, the estimated coefficient for the income variable on the relative change in service mix is negative. This implies a substitution effect, as physicians change their composition of laboratory tests to tests that are more expensive when fees decrease. Third, there is a small negative income effect for the number of laboratory tests ordered from clinical laboratories. Three dependent variables are constructed where the estimated coefficient for the income change variable is negative in all three specifications, suggesting that physicians who experience a loss of income from tests analysed at the office order more tests from clinical laboratories. The latter provides evidence of a spillover effect from the primary health care sector to the specialist health care sector.

These results are generally consistent with the theoretical predictions, and are in line with findings from earlier panel data studies of primary physician services in Norway. Neither Carlsen et al. (2003) nor Grytten et al. (2007) find negative income effects of fee changes on service production. However, neither study examined substitution and spillover effects as in this study. McGuire (2000) argues that income effects matter when studying fee changes and physician behaviour, but they may not be as empirically important as substitution effects, that is, how changes in fees for one service change the volume of other services.[24] A potential problem arising when physicians are paid on a fee-for-service basis is cost control (Prendergast, 1999). In theory, reducing fees to physicians is a simple mechanism for controlling costs. In practice, this may be difficult because of behavioural responses by physicians (Gruber et al., 1999). Our results provide new insights regarding physician responses to fee changes in primary health care, as we examine and find evidence for substitution and spillover effects. These results point out the importance of distinguishing between income and substitution effects.

While our findings have proven robust to various specification and robustness tests, the analysis has some limitations. First, our sample contains relatively few community physicians. The results for this group might have been different if the number had been larger. According to theory (Prendergast, 1999; Sørensen and Grytten, 2003), we should expect community physicians not to respond to fee changes. As the sample is representative of the population of community physicians in Norway, we have no reason to omit this group from the analysis. However, after comparing the results for community physicians in Tables 5 and A1, we have reason to believe the insignificant results are due to a 'small sample problem'

[24] See McGuire (2000, p. 514) for a discussion of this topic.

regarding explanatory power. Second, there is a possible endogeneity problem when estimating the effect of the fee change on (*ii*) the relative change in service mix because L_{t-1} enters into both sides of Eq. 5.[25] An alternative strategy would be to estimate the model using a fixed-effects instrumental variable method. On the one hand, it is difficult (if not impossible) to find any instrument that affects only the income change variable and not the service-mix variable because of the nature of their construction.[26] On the other hand, a simple check for correlation shows us that the two variables are only weakly negatively correlated, indicating that the variables are quite independent.[27] Further, the sign of the estimated coefficient is negative (as theoretically expected), and following the calculation in Wooldridge (2008) for determining the bias for the estimated coefficient for the income variable in a simple model (without any explanatory variables) indicates that the estimator is underestimated (e.g., should be more negative).[28] Even though this simple calculation can serve as a useful guide only, it suggests that while there is a substitution effect present, its size may be undetermined.

Combined, the findings have important implications regarding the ramifications of fee regulation. First, focusing only on the volume of responses for services where fees have been reduced, especially those involving several procedures, implies that one will obtain an incomplete picture as the service mix will probably change. One of the major concerns with the reduction in fees is that it may lead to deterioration in the quality of care, namely, an unwanted service mix or where some services are not supplied at all. Second, there is no evidence that physicians are following a target income strategy. McGuire and Pauly (1991) point out that when income effects are trivial or non-existent, substitution effects appear to

[25] This relates to a simultaneity bias problem where an explanatory variable is determined simultaneously with the dependent variable, making the explanatory variable correlated with the error term (Wooldridge, 2008).
[26] We attempt several estimations using fixed-effects instrumental variables. However, we have to conclude that data do not contain any useful instruments for solving the potential endogeneity problem.
[27] The correlation coefficient is –0.14. Calculating the variance inflation factor after running (*ii*) gives a value of 1.08. This suggests that there is no problem relating to multicollinearity.
[28] See Wooldridge (2008, p. 552) for a discussion of this topic.

dominate. Our results for Norwegian primary physicians appear to confirm this, thereby verifying the empirical importance of substitution effects.

Finally, it is evident that fee regulation in one part of the health care sector may lead to spillover effects into other parts of the health care sector. This has been shown for several types of procedures in specialist health care in the US (Yip, 1998; Mitchell et al., 2001), but not within a primary health care setting. Such spillover effects may not be negative if the cost of analysing tests is the same in both cases. However, analysing tests at clinical laboratories is overall more expensive than at the physician's office laboratory. Some tests have also been proven cost beneficial when analysed at the office, often because the test result is available immediately (Fauli and Thue, 2008). This indicates that fee regulation ought to be considered from a cost–benefit perspective, as well as in accordance with existing medical guidelines, instead of across the board. In summary, the results suggest that fee regulations have the potential to influence physician behaviour and help control government expenditure. However, failing to recognize the potential substitution and spillover effects tends to understate the effects of fee regulations on total spending. In this case, if the objective of the fee reductions is to control physician income, the authorities may not achieve any savings.

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Tables

Table 1
Reimbursement fees for laboratory tests 2001–04 in NOK

Year	Fees for laboratory tests (mean)		Co-payment[a]		Fee for immunology test[b]		Fee for PT–INR test[c]	
	NOK	Change (%)	NOK	Change (%)	NOK	Change (%)	NOK	Change (%)
2001	42.9		25		40		65	
2002	45.1	5.0	35	4.0	38	–5.0	70	7.7
2003	47.3	4.4	35	0.0	48	26.3	70	0.0
2004	33.7	–29.3	47	34.3	20	–58.3	47	–32.9
2001–04 (%)		–22.5		88.0		–50.0		–27.7

(a) Code 701a: Taking of blood samples for testing at the physician's office laboratory or for shipment to external clinical laboratory, (b) Code 705k: Immunology test, (c) Code 710: Prothrombin Time (PT)–International Normalized Ratio (INR) test.

Table 2
Variable definition

(*i*) Service level	Number of tests analysed at the office laboratory per consultation.
(*ii*) Service mix	Relative change in service mix between year *t* and *t–1* measured as average reimbursement for all laboratory services in year *t* and *t–1*, using reimbursement fees of year *t–1*.
(*iii*) Service level	Number of tests ordered from clinical laboratories per consultation
Income change	Magnitude of potential change in income measured as total laboratory services supplied in year *t–1*, multiplied by change in reimbursement fees between period *t* and *t–1* (in NOK 1,000).
Income change* community physician	Income change (in NOK 1,000)*community physician†
Equipment	Dummy = 1 if physician has cell-counter and dry-chemistry machines
Specialist	Dummy = 1 if physician is specialist in general medicine
Group practice	Dummy = 1 if physician is part of group practice
Sharing patient list	Dummy = 1 if physician shares patient list with other physicians
List size	Number of patients on the physician's patient list (log)
Women	Proportion of women in consultation (log)
Patient age < 6 years	Proportion of patients under 6 years of age in consultations (log)
Patient age > 68 years	Proportion of elderly > 68 years of age in consultations (log)
Number of diagnoses	Number of diagnoses per consultation (log)
Physician population	Number of man-labour years of physicians per 10,000 inhabitants in the municipality (log)
Rental costs	Average rental price for a standard residence in the economic region (log)
Cost of labour	Average salaries for all employees in the economic region (log)
Prop. high education	Proportion of individuals in the municipality with more than 12 years' schooling (log)
Prop. unemployed	Proportion of unemployed in the municipality (log)
Prop. disabled	Proportion of disabled pensioners in the municipality (log)

† The variable 'community physicians' is a dummy = 1 if physician is a community physician, 0 otherwise.

Table 3
Level and percentage changes, consultations, laboratory tests and laboratory tests per consultation, contract physicians, 2001–04

	Number of consultations per month		Number of laboratory tests per month		Number of laboratory tests per consultation	
Year	Actual	Change (%)	Actual	Change (%)	Actual	Change (%)
2001	260		117.8		0.453	
2002	267	2.7	116.7	–0.9	0.437	–3.5
2003	277	3.6	124.6	6.8	0.450	3.0
2004	288	4.0	124.9	0.1	0.434	–3.6
2001–04 (%)		10.8		6.0		–4.2

Table 4
Descriptive statistics, contract physicians, 2001–04

Variable	Pooled	2001	2002	2003	2004
Income change	–609.63	–	142.63	330.58	–2380.92
	(1602.73)		(377.08)	(341.08)	(1772.01)
Service-mix change	0.035	–	0.049	0.022	0.034
	(0.136)		(0.166)	(0.120)	(0.116)
Specialist	0.687	0.669	0.674	0.695	0.709
	(0.464)	(0.471)	(0.469)	(0.460)	(0.456)
Equipment	0.065	0.072	0.068	0.065	0.056
	(0.240)	(0.250)	(0.244)	(0.241)	(0.222)
Group practice	0.829	0.836	0.831	0.828	0.823
	(0.376)	(0.370)	(0.375)	(0.377)	(0.381)
Sharing patient list	0.070	0.070	0.072	0.071	0.067
	(0.255)	(0.255)	(0.258)	(0.256)	(0.251)
List size	1306	1296	1307	1313	1309
	(385)	(395)	(386)	(381)	(380)
Women	0.602	0.606	0.605	0.603	0.595
	(0.113)	(0.119)	(0.114)	(0.110)	(0.108)
Patients age < 6 years	0.60	0.063	0.059	0.057	0.060
	(0.038)	(0.046)	(0.036)	(0.035)	(0.035)
Patient age > 68 years	0.331	0.301	0.308	0.311	0.322
	(0.127)	(0.133)	(0.128)	(0.124)	(0.122)
Number of diagnoses	1.213	1.223	1.210	1.212	1.212
	(0.166)	(0.167)	(0.165)	(0.166)	(0.166)
Physician population	8.824	–	8.858	8.796	8.817
	(1.677)		(1.669)	(1.633)	(1.728)
Cost of labour	249 002	–	242 212	248 752	256 091
	(42 582)		(41 318)	(41 723)	(43 555)
Rental costs	11 698	–	11 126	11 293	12 658
	(3 997)		(3 894)	(3 754)	(4 153)
Prop. high education	0.217	0.210	0.214	0.219	0.226
	(0.048)	(0.047)	(0.048)	(0.047)	(0.047)
Prop. unemployed	0.0578	0.053	0.059	0.059	0.060
	(0.024)	(0.023)	(0.024)	(0.024)	(0.024)
Prop. disabled	0.063	0.061	0.063	0.064	0.064
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)

Standard deviation in parentheses.

Table 5
Estimation results, (*i*) number of tests analysed at the office laboratory and (*ii*) relative change in service mix, Models 1–3

Variable	Number of tests analysed at the office laboratory per consultation			Relative change in service mix		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Income change	.006***	.007***	.013***	–.002**	–.003***	–.007***
	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)
Income*comm.	–.007	–.002	.013	.022**	.017*	.001
	(.013)	(.013)	(.013)	(.010)	(.010)	(.010)
Specialist	–	.013*	.010	–	–.012	–.008
		(.007)	(.008)		(.012)	(.013)
Equipment	–	.096***	.085***	–	–.015	.001
		(.026)	(.027)		(.022)	(.022)
Group practice	–	–.052**	–.043*	–	.073	.057
		(.025)	(.027)		(.083)	(.087)
Sharing list	–	.033	.005	–	–.002	.019
		(.034)	(.032)		(.044)	(.048)
List size	–	.004	.007	–	–.020	–.024
		(.019)	(.022)		(.024)	(.026)
Women	–	–.043**	–.026	–	.046	.031
		(.021)	(.023)		(.032)	(.033)
Patients age < 6 years	–	–.001	–.001	–	–.037***	–.032***
		(.005)	(.005)		(.008)	(.009)
Patient age > 68 years	–	.042***	.034***	–	.047***	.054***
		(.010)	(.011)		(.015)	(.015)
No. of diagnoses	–	.164***	.117**	–	–.090	–.060
		(.057)	(.059)		(.091)	(.096)
Physician pop.	–	–	.006**	–	–	–.008**
			(.002)			(.004)
Cost of labour	–	–	.322***	–	–	–.105
			(.074)			(.127)
Rental costs	–	–	.056**	–	–	–.022
			(.026)			(.034)
Prop. high educ.	–	–	.044	–	–	–.244*
			(.082)			(.002)
Prop. unempl.	–	–	.012*	–	–	.002
			(.006)			(.010)
Prop. disabled	–	–	.079	–	–	–.114
			(.069)			(.088)
Cons	.417***	.415***	–3.839***	.034***	.112	1.044
	(.001)	(.139)	(1.114)	(.002)	(.180)	(1.770)
R^2	.013	.039	.060	.001	.014	.019
Obs.	6613	6490	6054	6518	6397	5971
Test for joint significance	–	F(9,4269) = 6.43 P-value = 0.000	F(6,3933) = 11.16 P-value = 0.000	–	F(9,4183) = 4.38 P-value = 0.000	F(6,3856) = 3.63 P-value = 0.001

Robust standard errors in parentheses; *, ** and **** indicate significance at the 10%, 5% and 1% level, respectively.

Table 6
Number of laboratory tests ordered from clinical laboratories (CL) per consultation

Variables	(1) Number of tests ordered from CL per consultation		(2) Number of tests ordered from CL per consultation		(3) Number of tests ordered from CL per consultation	
Year	Actual	Change (%)	Actual	Change (%)	Actual	Change (%)
2001	0.281		0.075		0.464	
2002	0.280	–0.4	0.076	1.3	0.467	0.7
2003	0.281	0.4	0.073	–3.4	0.471	0.9
2004	0.456	62.3	0.070	–4.1	0.488	3.6
2001–04 (%)		62.3		–6.7		5.2

(1) includes co-payment, (2) excludes co-payment, (3) includes co-payment and dummy for co-payment.

Table 7
Estimation results, (*iii*) number of tests ordered from clinical laboratories (CL), Models 2 and 3

Variable	(1) Number of tests ordered from CL per consultation		(2) Number of tests ordered from CL per consultation		(3) Number of tests ordered from CL per consultation	
	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3
Income change	–.049***	–.035***	–.003***	–.006***	–.008***	–.008***
	(.001)	(.002)	(.001)	(.001)	(.001)	(.001)
Income*comm.	–.050***	–.020**	.001	–.003	–.005	–.002
	(.008)	(.008)	(.004)	(.004)	(.006)	(.006)
R^2	.562	.639	.021	.042	.059	.064
Obs.	6490	6054	6490	6054	6490	6104
Test for joint significance	−	F(6,3933) = 64.51 P-value = 0.000	−	F(6,3933) = 12.22 P-value = 0.000	−	F(6.3933) = 1.47 P-value = 0.186

Robust standard errors in parentheses, *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively; control variables not reported.

Appendix

Table A1
Estimation results, community physicians, Models 2 and 3

Variable	Number of tests analysed at the office laboratory per consultation		Relative change in service mix		(3) Number of tests ordered from CL per consultation	
	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3
Income change	.004 (.013)	.027 (.020)	.009 (.012)	–.007 (.025)	–.014** (.006)	–.022*** (.010)
R^2	.050	.097	.078	.099	.069	.116
Obs.	416	327	394	314	416	327
Test for joint significance	–	F(6,197) = 1.80 P-value = 0.101	–	F(6,174) = 0.84 P-value = 0.623	–	F(6, 185) =2.85 P-value = 0.011

Robust standard errors in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively; control variables not reported.

Table A2
SUR results, Model 3

Variable	Number of tests analysed at the office laboratory per consultation	Relative change in service mix	(1) Number of tests ordered from CL per consultation	(2) Number of tests ordered from CL per consultation	(3) Number of tests ordered from CL per consultation
Income change	.014*** (.001)	–.009*** (.002)	–.034*** (.001)	–	–
Income*comm.	.010 (.009)	.002 (.015)	–.025*** (.007)	–	–
Income change	.014*** (.009)	–.009*** (.002)	–	–.005*** (.001)	–
Income*comm.	.010 (.009)	.002 (.015)	–	–.002 (.004)	–
Income change	.014*** (.009)	–.009*** (.002)	–	–	–.006*** (.001)
Income*comm.	.010 (.009)	.002 (.015)	–	–	–.002 (.006)
R^2	.063	.016	.426	.034	.038
Obs.	3908	3908	3908	3908	3908

Robust standard errors in parentheses; *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively; control variables not reported.

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