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Competition and Scale Economy Effects of the Dutch 2006 Health-Care Insurance Reform

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This paper investigates competitive behaviour and scale economies of the health-care insurance market in the Netherlands over the period 1995–2012. We focus on the impact on the market structure of the 2006 health-care reform, which replaced the dual system of public and private insurance with a single compulsory health insurance scheme in which insurance providers compete for customers in a free market. We start with estimating unused scale economies and find that, after the health-care reform in 2006, unused scale economies at around 20 per cent are much higher than before the reform (4 per cent), pointing to a relative increase of fixed costs. Our interpretation of this change is that fixed costs increased after the reform, as insurers now have to monitor care providers and negotiate with them about lower prices or higher quality. To measure competition directly, we apply a novel approach that estimates the impact of marginal costs as an indicator of inefficiency on either market shares or net profits. Over time, competition in health insurance has increased significantly, but reform-induced market turbulences in 2006 caused a fall in the average level of competitive pressure. After the reform, competition continued to improve.
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Introduction

In recent years, competition in the Dutch health-care insurance sector has undergone a series of changes, mostly facilitated by a fundamental reform of the health-care system in 2006, which aimed to increase cost-efficiency and innovation.[1] Under the new regime, the dual system of public and private insurance was replaced by a single compulsory health insurance scheme in which insurance providers compete for customers in a free market. The new regulatory structure also meant that the position of the government changed from a direct steering role (in terms of prices and volumes) to that of a supervisor surveying product quality and a level playing field.[2,3] The question we raise here is whether the policy shift under the

[1] Daley and Gubb (2011).
[2] Schäfer *et al.* (2010).
[3] The Parliament remains responsible for the composition of the basic health insurance package, while the Minister of health prescribes the “cost” price of the basic health-care package.

new regime did indeed have the intended effect on the health insurance market. To answer it, this study examines the structure of the Dutch health insurance market, particularly its efficiency and competitive behaviour, whereby the impact of the 2006 health reform on insurers' cost behaviour takes a central position. In light of the 2006 reform package, measuring competition and efficiency is an important issue. Furthermore, there is a need for a balancing act between sufficient and effective competition and a situation in which insurers seek "more subtle ways of risk selecting" in response to strong competition.[4] The health insurance reform seeks also to improve innovation and quality (dynamic efficiency), but public data to investigate that are not available, so that this paper focuses on static efficiency.

The health insurance market is an important actor in resolving risk and uncertainty and is significant, both in terms of volume and as a share of GDP. In 2013, net premiums written amounted to €41.4 billion (or 6.4 per cent of GDP) and total assets equalled €34 billion.

Measuring competition directly is difficult, particularly on a more detailed level, due to a lack of precise data on the costs and prices of individual health insurers. Therefore, scale economies are frequently used as an indirect substitute. The underlying assumption is that strong competition incentivises insurers to become more scale-efficient, for example, by forcing managers to reduce marginal costs in order to remain profitable.[5] Persistence of unused scale efficiency would indicate the absence of strong competition.[6] In order to capture this effect, we will measure scale efficiency by estimating a translog cost function.[7] In addition, we will employ a competition measure, which we refer to as the performance-conduct-structure (PCS) model, based on the efficient structure hypothesis advanced by Hay and Liu and Boone.[8] Underlying this approach is the idea that in a competitive environment, insurers experience an increase in market share if they pass on their efficiency gain (fully or partly) by lowering their output prices. Insurers enjoy also higher profits due to a larger market share and—if they keep part of their efficiency gains—a higher profit margin. In other words, efficiency is rewarded more highly amid heavier competition. For an overview, see Bikker and Van Leuvensteijn.[9] This measure has been employed in the past for the life insurance market[10] but never, to the extent of our knowledge, for health insurance. The PCS indicator would measure the extent to which existing efficiency differences between insurers are reflected in performance divergences. While there are alternative methods for measuring competition, such as the traditional Lerner index, the Panzar–Rosse model, concentration indices and the price–cost margin model, most of them are hampered by data insufficiencies, theoretical flaws or empirical failings.[11]

"Until recently very little research had been done on competition by health insurance firms".[12] While empirical research on the insurance industry is more developed, we hardly found any studies on health insurers. In most countries, health insurance is included in life

4 Daley and Gubb (2011, p. 9).
5 Raith (2003); Hay and Liu (1997).
6 Kox and Van Leeuwen (2011).
7 We follow the literature and use cost functions rather than production functions. See Coelli *et al.* (1998, pp. 43–49); Bikker and Bos (2008, p. 14).
8 Hay and Liu (1997); Boone (2001, 2008).
9 Bikker and Van Leuvensteijn (2015).
10 Bikker and Van Leuvensteijn (2008); Bikker (2016a).
11 Bikker and Bos (2008).
12 Gaynor and Town (2011, p. 83).

insurance. Cummins and Weiss[13] identify 74 studies spanning the period 1983–2011 and covering different aspects of both non-life and life insurance, with roughly half of them studying the United States (U.S.) market. Previous research into Dutch non-life insurance, which includes health insurance (and where health premiums written cover more than 50 per cent of total premiums), revealed substantial scale economies averaging above 10 per cent.[14] Similar results were found in studies focusing on the U.S. and several European countries as reported in the literature review. This paper contributes to the literature by applying the PCS measure of competition, which to date has been rarely used. We use a unique, not publicly available data set for the Dutch health industry for the period 1995–2012 that captures the effects of the 2006 health-care reform package. The results are interesting for other countries too, given that elements of this reform are also found elsewhere, e.g. in the Swiss and German health-care systems.[15] The Dutch approach with a stronger role for insurers to foster lower health-care prices and to boost health-care quality may also been expected in other countries.

The intention of the health-care reform is, among other things, to improve competition and cost-efficiency. We investigate whether this has indeed been realised. With respect to scale economies, we observe that the changes in the health-care insurance rules dominate any efficiency gain. Monitoring care providers, negotiating lower prices or higher quality, developing strategic policies, adjustments to new rules and advertising more to compete for clients are all activities with at least substantial fixed costs, so that a much larger scale is necessary in order to be scale-efficient. In other words, the optimal scale has increased substantially. Further, we observe gradual improvement in competitive behaviour over time, but a substantial, be it temporary, fallback in 2006. The latter may be due to the large reform-induced health insurance market turbulances. Lower marginal cost is used to improve profits (and bolster the solvency buffers) rather than gain larger market shares.

The remainder of this paper is organised as follows. The section "The Dutch health insurance industry" provides background information on the organisation and development of the Dutch health insurance market. The "Literature review" section reviews the literature on competition and scale economies in health insurance. The section entitled "Measuring competition and economies of scale" discusses the methodology behind estimations of competition, while the next section provides an overview of the data. The empirical findings on scale economies and competition, both before and after the reform, and a brief comparison with similar results in other insurance studies are shown in the "Empirical results" section. The last section provides concluding remarks.

The Dutch health insurance industry

In order to gain a better understanding of the health insurance industry, this section presents an outline of the sector in the Netherlands and the main recent events shaping its development. Prior to January 2006, the Dutch health-care system featured a complex structure of private and public insurance entities under the Compulsory Health Insurance Act (in Dutch: "Ziekenfondswet"), divided into three compartments. Basic health insurance was provided in the first

[13] Cummins and Weiss (2014).
[14] Bikker and Gorter (2011).
[15] Greß *et al.* (2007).

compartment: the mandatory National Health Service Institutions (NHSI) for everyone below the so-called NHSI income level. Covering 62 per cent of the population, the NHSI was financed through income-dependent contributions paid by employees, employers and social security providers. Those not qualifying for the NHSI scheme could take out voluntary private health insurance, carrying an age of entry-dependent insurance premium. NHSI insureds could expand the cover of their basic health insurance on the private health insurance market. A final compartment consisted of a public insurance scheme providing long-term care for the chronically ill funded out of social security premiums.

In 2006, the most comprehensive health insurance reform in the Netherlands since the Second World War merged the first two compartments into a single private but mandatory scheme. Private insurers provide a single compulsory basic health scheme and compete for business on the price of that package. All insureds pay a flat rate for the basic package, while all employers pay an income-dependent premium. The benefits are fully standardised and insurers are obliged to accept all applicants regardless of their health profile (i.e. no "cherry picking"). Due to this requirement, the system is one of managed competition, supervised by independent bodies, with insurers negotiating prices with health-care providers, and policyholders being free to change insurers every year.[2] Insurers with a proportionally older clientele are compensated by insurers with relatively green clients. The insured may supplement their basic package with extensions supplied by the market. The ultimate goal of the reform was "to encourage health insurers to increase the efficiency of the health-care provision by becoming prudent buyers of health services on behalf of their customers".[16]

Since 2006, health insurance has replaced both the former public-sector NHSI and the voluntary private insurance schemes for higher-income beneficiaries. The statistical break of 2006 is evident from Figure 1: health and accident premiums increased dramatically in that year due to the inclusion of the 17 NHSIs in the private health insurance market, which more than doubled the premiums written. This figure shows both the health monolines (insurers that deal with health insurance only) and the non-life multilines, which include a health line of business apart from property and liability. The multilines represent only a minor part of the market, particularly after the reform in 2006. Incidentally, these multilines are ignored in the empirical section, due to the absence of health-specific cost data.

Although in the years 2006 and 2007, health carriers were accepting losses in order to build market share, more recently we have seen a steady increase in health insurance premiums.[17] The reform year also marked a one-time peak in customer mobility for health insurance, when in the first months of 2006 the market registered 21 per cent of consumers changing health insurers, only to return to a low 4.4 per cent in 2007 and 3.6 per cent in 2008.[18] In recent years, this percentage recovered to 6.5 per cent.

The flaring of reform proposals in the public debate triggered a fresh wave of mergers and acquisitions in anticipation of the new health reform law. This is evident from Figure 2, as the Herfindahl–Hirschman concentration index (HHI)[19] increases from 2004

[16] Van den Ven and Schut (2009, p. 253).
[17] Swiss Re (2011); Leu *et al.* (2009).
[18] Leu *et al.* (2009).
[19] HHI is defined as the sum of the squared market share, expressed in percentages, so that theoretically, the HHI ranges between 0 and 10,000. Numbers are based on health insurance premium income and measured at aggregate level during 1995–2012.

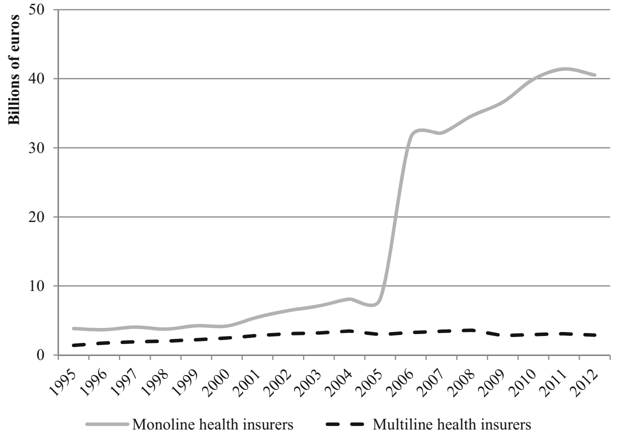

Figure 1. Gross health insurance premiums written.

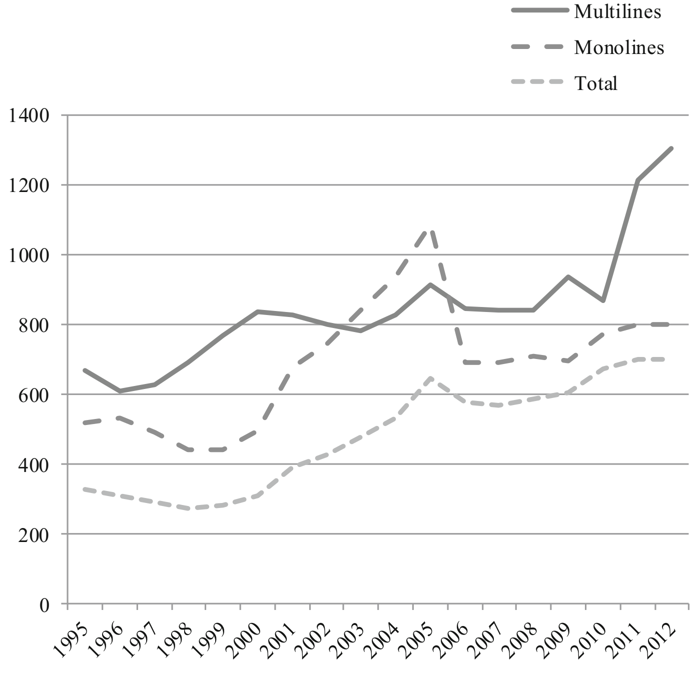

Figure 2. HHIs for the Dutch health insurance industry (1995–2012).

onwards, peaking just before the reform. According to Schäfer et al., "private insurers and NHSI merged into large companies in order to strengthen their competitive position and to obtain sufficient countervailing power, especially in relation to health-care providers". In 2006, we see the entrance of the public health insurance entities, which lowers the

Table 1 Concentration and number of health insurers over time

	Gross premiums			*Total assets*			*Number*
	Top 5	*Top 10*	*Top 20*	*Top 5*	*Top 10*	*Top 20*	
Monolines							
1995	0.43	0.60	0.79	0.47	0.67	0.85	64
2000	0.41	0.63	0.83	0.44	0.67	0.87	62
2005	0.60	0.84	0.96	0.56	0.78	0.95	43
2006	0.53	0.70	0.90	0.42	0.64	0.85	60
2010	0.57	0.74	0.92	0.47	0.69	0.89	49
2012	0.58	0.74	0.91	0.47	0.68	0.87	46
Multilines							
1995	0.41	0.58	0.75	0.36	0.54	0.73	78
2000	0.44	0.64	0.81	0.41	0.59	0.79	66
2005	0.47	0.67	0.85	0.44	0.63	0.84	53
2006	0.44	0.65	0.85	0.44	0.64	0.84	52
2010	0.50	0.75	0.91	0.48	0.70	0.90	46
2012	0.58	0.79	0.94	0.58	0.78	0.95	36

concentration index. After the reform, we see that consolidation resumed in 2010 and 2011, and—particularly for monolines—in 2012.

Table 1 shows the market shares of health monolines (top panel) and multilines (lower panel), expressed in gross premiums and total assets held. We observe consolidation in the run-up to the reform and, next, a decline in the top x market shares ($x = 5$, 10 or 20), when the public-sector health insurance entities enter the private insurance market in 2006. In the last years, the number of monolines decreases from 60 to 46. Apparently, smaller firms were discontinued, without substantially affecting market shares.

Literature review

Most literature on health reform concerns the U.S., which is of course strongly related to the conditions, institutions and laws in that country in the respective period and does not provide much valuable background to the recent Dutch reform. Therefore, this review focuses on the measurement of competition and scale economies of health-care insurers rather than on reforms. In most countries, health is part of the life insurance sector, as the level of health-care claims incurred is—and premiums may be—age-dependent. In the Netherlands, however, health forms part of non-life, or property liability. This is because they are typically annual policies. Some health insurers have health as their singular line of business (monolines), while many insurers combine various products and types of insurances (multilines). The major part of the literature deals with multilines or all types of insurers of the (life or non-life) insurance sector, particularly if data on costs and premiums are not split into separate types of business. An exception is Yang,[20] who also focuses on monoline health insurers.

[20] Yang (2006).

Direct measurement of competition in the life insurance market is rare.[12] Bikker and Van Leuvensteijn and Bikker[10] use the PCS indicator—sometimes referred to as the Boone index—to measure competition in the Dutch life insurance sector. They conclude that life insurance competition is weaker than competition in the industrial markets. Dafny[21] uses premiums in the conception of the Lerner index and finds for the U.S. private health market that they are larger for contracts with more profitable firms, particularly in concentrated markets, pointing to abuse of market power. Similarly, Choi and Weiss and Robinson[22] use prices as measures of market power. Others use the structure of the market, particularly the degree of concentration, as an indicator of—or basic condition for—competition, as in the structure-conduct-performance hypothesis.[23]

A frequently used indirect indicator of competition in the insurance industry is efficiency, commonly measured as unused scale economies or X-inefficiency. As stronger competition forces insurers to operate more efficiently, unused scale efficiencies or X-inefficiency could be indicative of less than perfect competition.

The existence of unused scale economies has been recorded in many *life* insurance studies, for the U.S.,[24] Canada,[20] 14 major European countries,[25] Spain,[26] France[27] and Turkey.[28]

Unused scale economies have also been recorded in many *non-life* insurance studies, for the U.S.,[29] 14 European countries,[25] Japan,[30] France,[27] Spain,[26] the Netherlands[14] and Turkey.[32]

All these studies present larger scale efficiency for small insurers and smaller scale efficiency for medium-sized and larger firms, while in Cummins and Rubio, Cummins and Xie and Bikker and Gorter[31] the largest insurers show diseconomies of scale, pointing to the existence of an optimal scale. An exception on finding unused scale economies is Toivanen,[32] who measures diseconomies of scale for the Finnish non-life industry at firm level over the entire size range, though, remarkably enough, economies of scale at branch level. For the literature on cost-efficiency of insurers (which is much wider than that of scale economies), we refer to the extended overview of Cummins and Weiss.[13]

Measuring competition and economies of scale

In order to measure competition, we first estimate scale economies, as an indirect measure of competition, and then proceed to compute a performance-conduct-structure (PCS) indicator as a direct measure of competition.

21 Dafny (2010).
22 Choi and Weiss (2005); Robinson (2004).
23 Dranove and Satterthwaite (2000); Gaynor and Vogt (2000); Herrick (2007); Gaynor and Town (2011).
24 Cummins *et al.* (2010).
25 Fenn *et al.* (2008).
26 Cummins and Rubio-Misas (2006).
27 Fecher *et al.* (1991).
28 Kasman and Turgutlu (2009).
29 Cummins and Xie (2013).
30 Hirao and Inoue (2004).
31 Cummins and Rubio (2006); Cummins and Xie (2013); Bikker and Gorter (2011).
32 Toivanen (1997).

Economies of scale

Economies of scale exist when the average cost of production is negatively related to a firm's output. While, in some industries, output is easily measured in terms of physical quantity, for a service-based industry such as insurance, one has to rely on value measures. Cummins and Weiss[33] report an extensive debate in the literature about the most appropriate measures of output. Keeping this discussion in mind, we follow Bikker and Gorter[14] and consider premiums and claims paid as possible measures of the insurance service of covering normal risks or expected losses. Additionally, we include total assets as second output measure, representing financial services. Total assets generate investment income while those assets also act as a buffer for lagged claims, unexpected losses and future health-care spending due to ageing of insured client populations.

We estimate scale economies using a translog cost function (TCF) as a second-order Taylor expansion around the mean, in natural logarithms. The main advantage of this functional form, which led to its extensive use in the related literature, is its ability to take on a U shape, so that the costs of production are high for low levels of output and then drop to a minimum point only to rise again with higher output. The TCF and alternative functional forms are investigated in Bikker.[34] The general cost function is expressed as $\mathrm{OC} = f(Y, P, T)$, with OC as operational cost, Y and P as output volume and input prices, respectively, and T as time. The related cost function for the present study is the following:

$$\ln \mathrm{OC}_{jt} = \alpha + \sum_i \beta_{Yi} \ln Y_{ijt} + \frac{1}{2}\sum_i \sum_k \gamma_{Yik}(\ln Y_{ijt} - \ln Y_{i\bullet\bullet})(\ln Y_{kjt} - \ln Y_{k\bullet\bullet}) + \sum_k \delta_k X_{kjt} + u_{jt}. \quad (1)$$

Here OC_{jt} is the total operational cost of health insurer j in year t ($t = 1, 2, \ldots, T$), defined as the sum of management cost (or administrative cost) and acquisition cost (that is, marketing and sales cost), and Y_{ijt} is output volume of type i ($i = 1, 2, \ldots, N$). Operational costs and output terms are expressed in logarithms, which reduces heteroskedasticity and generates elasticities as coefficients. The model contains squares and cross terms of output components in order to pick up any non-linearity in the cost elasticities—and hence economies of scale—across different size categories. All output types in the non-linear terms are expressed in deviation of their averages (in logarithms), calculated over all insurer–year combinations; cf. the Taylor series expansion. The average for output type i is denoted as $\ln Y_{i\bullet\bullet}$, with dots for the subindices over time and across insurance firms. The variables expressed as deviations from their averages help to split linear and quadratic effects of output on costs and simplify the interpretation of the coefficients, as explained below. X_{kjt} is control variable k ($k = 1, 2, \ldots, L$) and u_{jt} represents the random error component. These control variables include the available input prices.

Following the above definition of economies of scale, we express overall ray scale economies (SE) for insurer j in year t as

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[33] Cummins and Weiss (2014, pp. 26–33).
[34] Bikker (2016b).

$$\mathrm{SE}_{jt} = 1 - \sum_{i=1}^{N} (\partial \ln \mathrm{OC}_{jt} / \partial \ln Y_{ijt}) = 1 - \sum_{i=1}^{N} (\beta_{Yi} + \gamma_{Yii} (\ln Y_{ijt} - \ln Y_{i\bullet\bullet})). \tag{2}$$

The SE for the *average* health insurer is equal to $(1 - \sum_i \beta_{Yi})$ the sum of linear output elasticities. In that case, the squared terms disappear due to the fact that the log outputs are presented in deviation from their geometric averages.[35] If the value of SE is positive, costs increase at a slower rate than outputs, giving evidence of economies of scale (*i.e.* increasing returns to scale). In this case, consolidation at firm level is more likely, as there is an incentive to capitalise on unused economies of scale. If the value of SE is negative, there is evidence of diseconomies of scale and an incentive to become more efficient by reducing scale. A SE equal to zero would indicate constant returns to scale (CRS) and point to health insurers operating at minimum cost.

The PCS competition model

The well-known and often criticised structure-conduct-performance (SCP) paradigm explains performance from structure, drawing at the same time a conclusion about competition, see Bos[36] for an overview and a critical analysis. The opposite theory, the efficient structure (ES) hypothesis,[37] follows the reverse route and explains structure from performance. In line with the latter hypothesis, Hay and Liu and Boone[8] introduce a measure of competition from a model explaining structure from performance. Following Bikker and Van Leuvensteijn,[9] we call this measure the performance-conduct-structure (PCS) indicator. This direct competition measure was applied earlier to the life insurance industry by Bikker and Van Leuvensteijn and Bikker.[10] We use Hay and Liu's[38] theoretical model to explain the PCS indicator.

The inverse demand curve of the insurance industry is given by $p = f(Q)$, where Q is the market output defined as the sum of the outputs of each insurance firm j, $Q = \sum_j q_j$. Each insurer maximises profits by choosing q_j in the profit function below:

$$\pi_j = \left[f(Q) - c_j\right] q_j - F_j, \tag{3}$$

where c_j is the variable cost and F_j is the fixed cost. The first-order condition is

$$\frac{\partial \pi_j}{\partial q_j} = p - c_j + q_j \frac{dp}{dQ} \frac{\partial Q}{\partial q_j} = 0. \tag{4}$$

$\partial Q / \partial q_j$ is defined as equal to $1 + \lambda_j$, where $\lambda_j = (1 - \mathrm{ms}_j)/\mathrm{ms}_j$ reflects the conjectural variation, *i.e.* the expectation of firm j of the extent to which changes in its own decisions will affect the output of its rival firms; ms_j the market share of firm j. If we rearrange

[35] This is the first simplification, which is due to the functional form in Equation (1) of the non-linear output terms, that is, in deviation from the respective (geometric) mean. The second is that the cross-output terms in Equation (1) disappear entirely in Equation (2), after taking first derivatives.

[36] Bos (2004).

[37] Among others, Choi and Weiss (2005) provide evidence for the non-life insurance industry that supports the efficient structure hypothesis.

[38] Hay and Liu's (1997).

Equation (4), divide both sides by p and define $\frac{q_i}{p}\frac{dp}{dQ}$ as $\frac{1}{E}$, the inverse of the demand elasticity, the following equation results:

$$\frac{p-c_j}{p}=\frac{\mathrm{ms}_j}{E}\left(1+\lambda_j\right)\quad\text{or}\tag{5}$$

$$\mathrm{ms}_j=\left(1-\frac{c_j}{p}\right)\frac{E}{1+\lambda_j}.\tag{6}$$

Equation (6) shows that a lower cost level for firm i is associated with a higher market share. When n insurers are considered to generate positive output levels on the market, we can sum Equation (5) across all firms $k = 1,\ldots, n$ (including firm j):

$$\frac{np}{p}-\frac{\sum c_k}{p}=\frac{1+\sum \mathrm{ms}_k\lambda_k}{E}\quad\text{or}\quad p=\frac{\sum c_kE}{nE-1+\sum \mathrm{ms}_k\lambda_k}.\tag{7}$$

Dividing both fraction terms on the right-hand side by nE yields

$$p=\left(\sum c_k/n\right)\Big/\left[1-\left(1+\sum \mathrm{ms}_k\lambda_k\right)\Big/nE\right].\tag{8}$$

Substituting Equation (8) into Equation (6) yields the following:

$$\begin{aligned}\mathrm{ms}_j&=\frac{E}{1+\lambda_j}\left(1-\frac{c_j}{p}\right)=\frac{E}{1+\lambda_j}\left(1-c_j\frac{1-\left(1+\sum \mathrm{ms}_k\lambda_k\right)/(nE)}{\sum c_k/n}\right)\\&=\frac{E}{1+\lambda_j}\left(1-\left(1-\frac{1+\sum \mathrm{ms}_k\lambda_k}{nE}\right)\frac{c_j}{\sum c_k/n}\right)\end{aligned}\tag{9}$$

Given that in a Nash–Cournot equilibrium $\lambda_k = 0$, the final model becomes

$$\mathrm{ms}_j=E-\left(E-\frac{1}{n}\right)\frac{c_j}{\sum c_k/n}.\tag{9$'$}$$

The coefficient of $c_j/(\sum c_k/n)$ is consistent with the hypothesis that firms with lower (relative) costs achieve higher market shares. Based on the above theoretical model, Hay and Liu[39] develop an empirical model relating marginal costs to market shares (and profits). We adapt this model for this paper as

$$\ln \mathrm{MS}_{jt}=\alpha+\beta_t\ln \mathrm{MC}_{jt}+\varepsilon_{jt}.\tag{10}$$

The dependent variable $\ln \mathrm{MS}_{jt}$ represents the market share of insurer j in year t, in logarithm form to correct for heteroscedasticity. As the market shares add up to one each year, we substitute the restriction $\mathrm{MS}_{pt} = 1 - \sum \mathrm{MS}_{jt}$ for each year (summing over 1, 2, …, $p-1$) into the model equation by dividing each observation by that of the pth insurer:

$$\ln(\mathrm{MS}_{jt}/\mathrm{MS}_{pt})=\alpha+\beta_t(\ln \mathrm{MC}_{jt}/\mathrm{MC}_{pt})+\varepsilon_{jt}.\tag{11}$$

Hereby, we apply an extension of the linear logit model, inspired by Theil.[39] The marginal cost of insurer j at time t is represented by the term MC_{jt}. Since it cannot be observed, it is estimated from the translog cost model in Equation (1) using the following formula:

$$\mathrm{MC}_{jt} = \sum_i \mathrm{MC}_{ijt} = \sum_i \left(\frac{\partial \ln \mathrm{OC}_{jt}}{\partial \ln Y_{ijt}}\right)\left(\frac{\mathrm{OC}_{jt}}{Y_{ijt}}\right). \tag{12}$$

The coefficient of ln MC_{jt}, β_t, an elasticity, is the PCS indicator of year t. This indicator is expected to have a negative sign, as more efficient firms will obtain higher market shares. In absolute terms, low negative values are interpreted as weak competition and vice versa, while 0 would mean no competition at all. These equations start with assuming that the process of insuring health care is rather homogeneous.

Following Hay and Liu and Bikker and Van Leuvensteijn,[40] we estimate additional models with net profit as an alternative performance indicator. Note that profit can be seen as market share times profit margin. The profit measure captures the idea that the industry rents are an inverse function of competition, reallocating profits to the most efficient firms and proving the selection effect of competition. Although it is acknowledged that other unobserved sector-specific factors may affect the PCS indicator, we can, within bounds, compare PCS indicators across industries and sectors, and over time.

Data on health-care insurance

We use regulatory data of the Nederlandsche Bank from the period 1995–2012. All value variables are deflated to 2010 price levels using the Consumer Price Index in order to avoid spurious correlations. The raw data set consists of 1,097 health-care insurance monoline observations, but we exclude 66 observations due to either missing data or negative values for output, cost or net premiums, as is possible for run-off firms. In terms of value losses due to exclusion, the discarded observations concern only 1.9 per cent of total premiums (over the full sample). The resulting data set comprises 1,031 observations of health-care monolines from 134 different entities used in the calculations. This forms an unbalanced panel due to firm exits and entrances, mergers and acquisitions, and data selection. Apart from monolines, we also have 1,077 observations of multiline insurers with health and other non-life lines of business (after "cleaning"), not used in the estimations, in 2012 covering less than 7 per cent of gross premiums. Table 2 provides an overview of the developments in the key health-care insurance model variables over time.

Gross premiums, in prices of 2010, show a strong growth over the years, and a structural break in 2006, due to the health-care reform-induced inclusion of the former public health services in the private insurance sector. Note that existing insurers increased their market shares and that the former public NHSI entered this private sector market. Total assets, as technical provision for, e.g. pending and future claims, grew too, but the structural break in 2006 was less spectacular, as the NHSI typically had lower capitalisation. Most ratios are quite stable over time, except the more volatile "profit margin" and "net investment income". The operational cost ratios are lower after 2006, due to the strong increase in

39 Theil (1969).
40 Hay and Liu (1997); Bikker and Van Leuvensteijn (2008).

Table 2 Developments in key health insurance model variables over time (monolines)

	1995	*2000*	*2005*	*Exclusive of NHSI*			*Including NHSI*		
				2006	*2010*	*2012*	*2006*	*2010*	*2012*
Gross premiums written (GP)[a]	81	83	204	392	351	341	560	815	840
Total assets (TA)[a]	118	155	241	317	387	478	411	647	797
TA/GP	1.44	1.87	1.18	0.81	1.10	1.40	0.73	0.79	0.95
Claims incurred/GP	0.88	0.94	0.86	0.92	0.85	0.88	0.94	0.89	0.89
Operational costs[b]/GP	0.10	0.14	0.12	0.07	0.07	0.08	0.06	0.04	0.05
Profits/GP	0.08	0.00	0.08	−0.01	0.05	0.07	−0.01	0.02	0.05
Net investment income/GP	0.08	0.10	0.07	0.02	0.03	0.07	0.01	0.01	0.03
GP stock insurers/GP	0.49	0.58	0.75	0.52	0.88	0.87	0.57	0.80	0.80
% of stock insurers	0.48	0.57	0.58	0.63	0.82	0.81	0.63	0.80	0.80
Distribution or acquisition ratio	0.03	0.04	0.02	0.01	0.03	0.04	0.01	0.01	0.01
Reinsurance/GP	0.01	0.02	0.01	0.06	0.05	0.03	0.06	0.06	0.04
HHI[c]	520	497	1086	785	722	704	693	774	799
Equity/TA	0.38	0.36	0.41	0.30	0.35	0.37	0.28	0.27	0.30
Number of insurers	64	62	43	49	33	31	60	49	46

[a]In millions of euros, 2010 prices.

[b]Operational costs are defined as management and acquisition costs.

[c]HHI is defined as the squared percentage market shares of health monolines per year, based on gross premiums, see Figure 2.

premiums. The share of stock-based insurers both in gross premiums and numbers is increasing over time, particularly in the last sample years. The equity ratios fall when totals assets increase. The ratio slightly recovers in the last years. The HHI concentration index went up in the years before the reform, but dropped in 2006.

The straight line in Figure 3 presents the per unit cost figures for health monoline insurers of different sizes, based on gross premiums, while the striped lines indicate the averages of the highest and lowest cost quartile. The unit costs fall sharply with size (with one interruption), indicating large unused scale economies. Of course, we need the empirical version of regression model (1) to take all relevant explanatory variables into account and to measure unit cost more precisely. The spread of unit costs within each size class is huge, particularly for small firms, indicating heterogeneity, inefficiency or a combination of the two. This spread falls gradually for larger health insurers.

Empirical results

This section presents scale economy and competition estimates for health insurance monolines. In addition to full sample results, estimations are split into the pre-reform and post-reform years.

Estimates of unused scale economies

The key question is whether the cost behaviour of health insurers has changed as a consequence of the 2006 health reform. Therefore, we estimate the translog cost model of

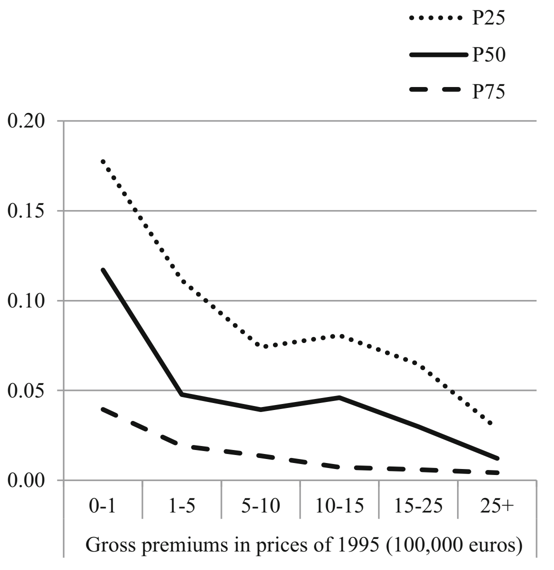

Figure 3. Average cost by quartile and by health insurer size class (1995–2012).

Equation (1) using the data set from 1995 to 2012 in order to obtain a measure of scale economies (SE). Given the available data described in the previous section, the final operational cost (OC) model reads as

$$\ln \mathrm{OC}_{jt} = \alpha + \sum_i \beta_{Yi} \ln Y_{ijt} + \sum_i \sum_k \gamma_{Yik} (\ln Y_{ijt} - \ln Y_{i\bullet\bullet})(\ln Y_{kjt} - \ln Y_{k\bullet\bullet}) \\ + \delta_1 \ln \mathrm{Realwage}_t + \delta_2 \mathrm{Stock}_{jt} + \delta_3 \mathrm{Acq}_{jt}/\mathrm{OC}_{jt} + \delta_4 \mathrm{HHI}_t + \delta_5 \mathrm{Time}_t + u_{jt}. \quad (13)$$

We include two output measures in our model: (i) gross premiums written or claims incurred (Y_1) and (ii) total assets (Y_2), so that $i = 1, 2$; j refers to insurance firms and t to time. Therefore, SE is calculated as one minus the sum of the two respective linear output coefficients ($1 - \beta_{Y1} - \beta_{Y2}$), see Equation (2). The second sum term in the equation refers to the squared output terms and the cross term, all with the variables in deviation from their (geometric) means.

Furthermore, the model contains one input price, viz. the real wage rate, represented by the logarithm of the hourly cost of labour. In the absence of health insurer-specific prices, we use the real wage index for the financial sector, to take development over time into account. A dummy for stock companies (*Stock*: 1 for stock insurers and 0 for mutual firms) tests the effect of organisational form on cost performance. Agency theory hypothesises that stock ownership can prove more effective due to its ability to reduce the agency costs (such as negotiation, information, litigation but also opportunity costs) associated with conflicts between owners, managers and policyholders.[41] In this situation, mutuals will exhibit higher costs than stock companies, all else held constant: the expense preference hypothesis. The recent credit crisis has shown that the agency theory hypothesis "that stock

[41] Mayers and Smith (1988).

ownership can prove to be more effective" may be too optimistic. The choice of distribution strategy, represented by the ratio of acquisition costs to total costs, $\mathrm{Acq}_{jt}/\mathrm{OC}_{jt}$, may impact highly on costs, so that a positive coefficient is expected. While the above controls (except *Real wages*) vary at firm level, the premium based Herfindahl–Hirschman Index (HHI) is calculated at industry level with variations limited to time. We expect a positive coefficient for this variable, as higher concentration may indicate less competition and lower pressure on companies to economise on cost. Lastly, a time variable is included to reflect technical progress, so that its coefficient is expected to be negative.

The estimates are obtained with OLS rather than panel estimations. If a fixed-effect (FE) parameter were estimated for each insurer, the average *level* of size or output over time would be absorbed by the FE parameters, which would eliminate the richest source of information with respect to the scale effect measurement. All variables are deflated to 1995 prices and there is no indication of multicollinearity, as no pairwise correlation between the independent variables exceeds 0.60. In addition, we correct for heteroskedasticity using the HC3 estimator, as suggested by Davidson and MacKinnon.[42] The fourfold constant returns to scale (CRS) hypothesis assumes that $\beta_{Y1} + \beta_{Y2} = 1$ (linear), $\gamma_{Y11} = \gamma_{Y22} = 0$ (quadratic) and $\gamma_{Y12} = 0$ (cross-output) and is rejected for all models. See the last rows of Tables 3, and A1 and A2 in the Appendix.

Table 3 presents results based on premiums as first output measure, while Table A1 in the Appendix shows the outcomes based on claims incurred. Both approaches lead to a similar conclusion, but we prefer the premiums model, as claims are somewhat more volatile, which leads to a downward errors-in-variable bias in the output coefficients and hence to overestimation of scale economies.

Table 3 presents the results for the entire period, as well as for the pre- and post-reform years separately. The full sample and post 2006 models have been estimated both for (i) all observations and (ii) observations exclusive of the former public NHSI, which entered the sample in 2006. This split allows the distinguishment of the changes of (1) the health insurance rules and (2) the composition of the health insurance providers. Furthermore, we applied also *weighted* regression for all samples, where the weight is the square root of premiums as a proxy for size. Weighted regression recognises the greater economic importance of larger health insurers. Table 3 presents the major results.[43]

The average scale economies (SE) for the full period equals 17 per cent using unweighted regression, and 13 per cent for weighted regression, the latter reflecting that larger insurers have lower unused scale economies. Exclusion of NHSI has hardly or no effect here (not shown). In the years before 2006, SE were only 4 per cent, while after the reform years, SE were no less than 23 per cent (exclusive of NHSI, both weighted and unweighted) or 18 per cent (including NHSI, weighted; or 21 per cent, unweighted). As inclusion or exclusion of the public NHSI has hardly any effect, we attribute the large increase in SE to the change in the health insurance rules: insurers now have more room to negotiate with health-care providers on prices and quality of care. Under the new regime, the fixed costs increased due to (i) monitoring care providers, (ii) negotiating lower prices or higher quality, (iii) developing strategic policies, (iv) adjustments to new rules and (v) advertising more in order to compete for clients; all activities with at least substantial

42 Davidson and MacKinnon (1993).

43 Results not presented in Table 3 are available from the author upon request.

Table 3 Scale economy estimates of health insurance based on premiums (1995–2012)

	Full period		*Pre-2006*	*Post-2006*	
	Incl. NHSI Unweighted	*Incl. NHSI Weighted*	*Excl. NHSI Unweighted*	*Excl. NHSI Unweighted*	*Incl. NHSI Weighted*
Gross premiums (in logs)	0.50***	0.56***	0.68***	0.44***	0.49***
Ditto, squared[a]	−0.04***	−0.04***	0.01	−0.04*	0.05***
Total assets (in logs)	0.33***	0.34***	0.27***	0.32***	0.33***
Ditto, squared[a]	−0.07***	−0.04***	−0.09***	0.03	0.11***
Cross term GP & TA[a]	0.09***	0.06***	0.10***	0.00	−0.13***
Real wage (in logs)	0.86**	[1]	[1]	[1]	[1]
Distribution or acq. ratio	1.02***	0.70***	0.97***	1.03***	0.78***
HHI/100	0.06	0.00***	−0.41***	0.01	−0.00***
Stock insurers	0.07	0.16***	0.23***	−0.08	0.01***
Time	–	−0.04***	0.02**	−0.04**	−0.08***
Constant	4.50***	5.03***	3.96***	5.85***	6.41***
Scale economies (SE)	0.17	0.10	0.04	0.23	0.18
SE, 25th percentile (small)	0.49	0.36	0.26	0.29	0.56
SE, 50th percentile	0.20	0.14	0.03	0.26	0.06
SE, 75th percentile (large)	−0.11	−0.11	−0.17	0.20	−0.29
Number of observations	1031	1031	664	271	367
R^2, adjusted (in %)	88.6	86.4	87.9	91.4	87.5
F test on CRS[b]	44.99***	16,527***	21.77***	36.40***	9,671***

[a]Squared and cross terms are in deviation from their average value.

[b]Critical value of the CRS test statistic (with four restrictions) at 1 % significance ranges from 3.34 to 3.36, depending on the degrees of freedom.

Notes: The indices *, ** and *** denote significant difference from zero at, respectively, the 90, 95 and 99 % confidence levels. Total costs, outputs and the wage index are expressed in 2010 prices.

fixed costs. Hence, the optimal health insurer size increased after 2006. Apparently, competitive pressure in the post-2006 years has, so far, been insufficient to drive out these unused scale economies. One objective of the health insurance reform was to increase competition and efficiency. Yet, while steps in the right direction may have been taken, further scale efficiency improvements seem possible.

Note that CRS is rejected for each of the three models (see the last row of Table 3), hence SE vary across the size distribution. Using Equation (2), we calculate scale economies for the 25th, 50th and 75th percentile of both the premium and the total assets size distributions. See the bottom panel of Table 3. Under concavity of the cost elasticity, SE is larger for small insurers and smaller for large companies.[44] For all but one sample in Table 3, scale economies indeed decrease for larger health insurers,[45] while the largest entities are even beyond the optimal size and therefore operate under decreasing returns to scale.

Turning to the other model variables, we observe that the *real wage* coefficient in the full sample has the expected value of around 1, which points to homogeneity in prices. For the

[44] Concavity exists when at least one of the squared output terms has a significant positive coefficient.

[45] This is in line with what was found earlier for other financial institutions: non-life insurers (Bikker and Gorter 3), life insurers (Bikker 2016a), pension funds (Bikker 2016b) and banks (Hughes and Mester 2013).

two subperiods, the real wage increases over time were probably too small to exert a significant influence on costs.[46] Therefore, we restricted this parameter to a value of 1, and, instead, included a time trend variable,[47] with no consequences for the other results. Spending more on *acquisition and distribution activities* has a significant positive affect on costs, as expected. The *concentration* measure HHI (see Figure 2) has a significant negative coefficient is most samples, which may point to larger possibilities of tacit collusion between insurers in a more concentrated market, or to other cost advantages of having fewer competitors. In most samples, the cost level of *stock companies* is significantly higher compared to that of mutual insurers. This positive result contradicts the expense preference theory, which predicts stock insurers to be more cost-efficient than mutuals. Such a contradiction was also found by Bikker and Gorter, Eling and Luhnen and Cummins *et al.*[48] The goodness of fit of the models is satisfactory with an adjusted R^2 of around 90 per cent.

As a first robustness test, we estimate Equation (13) also as a stochastic cost frontier analysis (SCFA) model, wherein the error term is split into two components: a model error and an X-inefficiency term.[49] The estimation results are presented in the Appendix, Table A2, Column 1. The parameter estimates that determine the scale inefficiency hardly differ from the OLS model (Table 3, Column 4). Hence, the scale economy estimates appear to be robust. This also holds for the marginal cost estimates, derived from this cost model, which are used in the next section. The X-inefficiency estimates resulting from the SCFA are high at, on average, around 69 per cent, as often found in the literature,[13] which corresponds to the high spread in costs per size class observed in Figure 3. Of course, these estimates include insurance firm heterogeneity and possible noise (as long as it has a positive sign), besides the key component of X-inefficiency: managerial inability to perform at best practise level.

As a second and third robustness check, we replace the TCF of Equation (13) by either a simplified unrestricted Laurent function (SULF), which is an generalisation of the TCF, or a hyperbolically adjusted Cobb–Douglas (HACD) model, which is an alternative specification.[34] The estimation results are presented in the Appendix, Table A2, Columns 3 and 4. A joint F test on the two additional inverse terms in the SULF makes clear that their coefficients are not significantly different from zero, so that the TCF is not rejected. The scale economy estimates of the HACD are also similar to those of the TCF. We conclude that the scale economy estimates are robust.

Direct measurement of competition

To investigate the effect of the 2006 health-care reform on competition, we apply the PCS indicator model to health insurance monolines separately, both for the entire sample period and the sub-periods before and after 2006. The empirical model based on Equation (11) reads as

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[46] A Wald test on homogeneity in input prices is not rejected. All test results are available from the authors upon request.

[47] Note that the coefficients of the variables that represent a trend and are invariate across insurers (wage index, HHI and time) should be considered with greater caution, due to possible multicollinearity.

[48] Bikker and Gorter (2011); Eling and Luhnen (2010); Cummins *et al.* (2004).

[49] Coelli *et al.* (1998).

$$\ln(\mathrm{MS}_{jt}/\mathrm{MS}_{pt}) = \alpha + \beta_t(\ln \mathrm{MC}_{jt}/\mathrm{MC}_{pt}) + \gamma(\ln \mathrm{MS}_{j,t-1}/\mathrm{MS}_{p,t-1}) + \theta\,\mathrm{Time}_t + \varepsilon_{jt}. \quad (14)$$

Following Hay and Liu,[34] we introduce a one-year lag of the market share variable to capture lagged adaptation: a permanent change in marginal costs may have a gradual upward effect on market shares. Therefore, a positive coefficient is expected on the lagged term. Furthermore, we include a time variable.

We estimate two variants of this model, with either market shares (with $\beta_t = \beta$ for all t) or profits after tax as independent variables, each expressed in logarithms.[50] The key explanatory variable is cost-efficiency, where we use the estimated marginal costs (MC) as calculated according to Equation (12).[51] Note that marginal costs do not include unused scale (in) economies, as the constant costs are ignored. To confirm that, we have re-estimated Equation (13) with *MC* instead of total costs and indeed, do not observe any relationship with output. Hence, reversed causality, that is, a potential impact of market share (size) on efficiency, is not a problem in our analyses. The results in Table 4 refer to health monoline insurers for the entire sample period 1995–2012, but excluding 2006, because for that year, we do not have lagged market shares for either new health-care insurance entrees or merged health-care insurers. As an alternative including 2006, we also estimated a non-dynamic version of Equation (14), i.e. without one-year lagged market shares (keeping $\beta_t = \beta$ for all t. See Table A3 in the Appendix). As above, the full sample and post-2006 models have been estimated both for (i) all observations and (ii) observations exclusive of the former public NHSI. Furthermore, we also applied *weighted* regression for all samples, where the weight is the square root of premiums as proxy of size.[52]

Table 4 presents estimates using the more suitable fixed-effects approach, which picks up persistent insurer-specific, not modelled conditions that may affect market shares or net profits and hence avoids omitted variable bias.[53] A disadvantage may be that FE estimates ignore the average levels of market shares and efficiency. For instance, an inefficiency which was persistent over the entire sample period, would be ignored, i.e. picked up by the FE coefficient. The OLS estimates, not shown here,[54] confirm the presence of large, insurer-specific missing variables which contribute to persistent market shares and net profits, as the respective lagged coefficients are much higher than in the FE models. The OLS estimates of the long-term PCS indicator showed a similar pattern as presented in Table 4, with—in absolute terms—higher values but lower levels of significance.

The long-term PCS indicator estimate of the full sample for market shares is −0.63 and highly significant. Splitting the sample at the regime shift year 2006 shows that market shares were sticky before 2006 (lagged market share coefficient is 0.69 and statistically significant), but respond immediately to marginal costs after the reform year (no significant lag). Free competition on customers have apparently worked well. The long-term PCS

[50] Due to the functional form of the model, companies reporting negative profits (losses) are excluded from the analysis. However, this is not expected to create a bias in the results (see Boone 2008).

[51] We prefer the detailed model-based estimates of marginal costs (MC) over alternative inefficiency measures such as data envelopment analysis (DEA) and the stochastic cost frontier approach (SCFA). DEA ignores the existence of model errors and is very sensitive for measurement errors. SCFA inefficiency estimates includes all types of heterogeneity and of possible not explained noise, as long as its sign is positive.

[52] Results not presented in Table 4 are available from the author upon request.

[53] A random-effect model was rejected by the Wu–Hausman test, in favour of the fixed-effects model.

[54] Available from the author upon request.

Table 4 FE estimates for the dynamic health insurance PCS model (1995–2012, excl. 2006)

		Full data set	*Pre-2006*	*Post-2006*			
		Incl. NHSI		*Incl. NHSI*	*Excl. NHSI*	*Incl. NHSI*	*Excl. NHSI*
		Unweighted	*Unweighted*	*Unweighted*	*Unweighted*	*Weighted*	*Weighted*
Market share model							
MC, ln	β	−0.18***	−0.21***	−0.35***	−0.21**	−0.22***	−0.13*
Market share, lag, ln	γ	0.72***	0.69***	−0.12	−0.07	−0.16	−0.30
Long-term PCS:	$\beta/(1-\gamma)$	−0.63***	−0.68***	−0.31***	−0.20**	−0.19**	−0.10*
# of observations		812	533	279	202	279	202
R^2 overall (in %)		97.3	95.9	8.2	2.5	69.5	93.7
R^2 within (in %)		63.4	67.9	15.5	10.2	9.2	14.5
Profit model							
MC, ln	β	−0.40***	−0.49**	−1.51***	−1.72***	−1.19*	−1.32*
Profits, lag, ln	γ	0.08	0.02	−0.07	−0.09	−0.12	−0.07
Long-term PCS:	$\beta/(1-\gamma)$	−0.40***	−0.49**	−1.51***	−1.69***	−1.06*	−1.23*
# of observations		482	319	163	119	163	119
R^2 overall (in %)		26.1	4.4	8.9	2.4	4.6	3.0
R^2 within (in %)		15.4	12.2	13.2	12.7	19.1	9.3

Notes: Indices *, ** and *** denote significant difference from zero at, respectively, the 90, 95 and 99 % confidence level. The long-term effect is calculated as $\beta/(1-\gamma)$ times respective coefficient.

estimate before 2006 is, at −0.68 in absolute terms larger than after 2006, ranging from −0.10 to −0.31. The former result points to *quicker* (short-term) responses to marginal costs after 2006, while the latter suggests *weaker* long-term reactions. Weighting and exclusion of NHSI have little effect in the full sample estimation (not shown), but both reduce—step by step—the marginal cost coefficient.

If we regard the profit model MC elasticities, we observe for the entire sample period an estimated long-term effect of −0.40, but a very deviating pattern when we consider subsamples: high values in absolute terms (ranging from −1.19 to −1.72) after the reform, versus −0.49 before 2006. Apparently, the reform had little or an adverse impact on the level of market share dynamics, but a substantial favourable influence on profit dynamics. Exclusion of the former NHSI slightly raises the PCS coefficient, suggesting that the NHSI's profit efficiency is slightly lower than that of the commercial insurers. Weighting also lowers that coefficient: apparently, larger insurers have a somewhat lower level of profit dynamics. One possible interpretation of the PCS results is that a substantial part of profits have been used to build up larger solvency buffers, focusing less on gaining market shares. In Table A3 of the Appendix, we simplify our model by deleting the lagged market share (or proft) variable (that is $\gamma = 0$), to avoid the necessary deletion of the 2006 observations as in the dynamic model. The results are fairly similar. The "Annual estimates of the PCS indicator" section below discusses more detailed annual estimates, which helps to explain the outcomes of Table 4.

These results are fairly well reproduced when marginal costs calculated according to Equation (12) are replaced by average costs (AC), see Table A4 in the Appendix.[55]

[55] Average costs are less precise as they do not distinguish between fixed and variable costs. However, it is quite common to approximate average variable costs by average costs. Average costs results are available from the author upon request.

Apparently, the quick and dirty approach of average costs as efficiency measure—ignoring fixed costs—functions well.

An absolute benchmark for the long-term effect of marginal costs on market shares or profits, $\beta/(1-\gamma)$, is absent. In order to judge the intensity of competition, we need to compare our results with similar estimates from other industries. In their study of the banking sector, Van Leuvensteijn *et al.*[56] use the market share PCS model and find that the β indicator averages -2.5 in the long run, compared to our value of -0.34 to -0.68.[57] Bikker[58] investigates the life insurance industry using a model similar to ours, which facilitates comparison. For the FE estimate of the long-term effect, he finds a value of -0.92, a bit higher in absolute terms than we observe for health. Creusen *et al.*[59] estimate the PCS model based on profits for the Dutch manufacturing and service industries and find elasticities between average variable costs and profits of around -5.7 and -2.5, respectively, much higher in absolute terms than our FE health profit estimate ranging from -0.42 to -1.30. Hence, we conclude that the health insurance sector is less competitive than the banking, manufacturing and service industries and even less competitive than life insurance.

Annual estimates of the PCS indicator

In order to capture the development of competition over time, the FE model of the PCS indicator is also estimated according to Equation (14), with a different β for every year. Table A5 in the Appendix presents estimation details, while Figure 4 provides the annual impact of marginal costs on health-care market shares over time. This is a time-dependent variant of the market share-based PCS model of health insurers shown in the upper panel of Table 4. The PCS indicator follows a clear downward trend towards heavier competition in the years before 2006, possibly reflecting preparations for the reform. In 2006, the year of the health-care insurance reform, competition jumps to a lower level, with β moving from -0.68 to -0.26. From direct observations, we know that in 2006 consumers changed their health insurer in much larger numbers than normally. Apparently, during the reform-induced market turbulences, the usual marginal cost–market share relationship was less representative. After 2006, the PCS competition indicator resumed its regular downward path towards heavier competition without, however, reaching its pre-reform level by 2012. These regular downward trends are remarkable as the estimated β_ts are completely independent. The PCS indicator β is significantly different from zero in all years since 1997, pointing to a dynamic effect of cost-efficiency on market shares. Overall, its level in absolute terms remains fairly low.

Figure 4 also shows the annual PCS indicators when the former public NHS institutions are excluded. The results are fairly similar, be it at an—in absolute terms—lower level. Clearly, the change of health insurance rules caused the big shift in 2006 and not the introduction of the NHS institutions. Also, weighted regression results show a similar picture.

Figure 5 presents the annual impact of marginal costs on health insurance profits after taxes, estimated with a time-dependent variant on the model shown in the lower panel of

56 Van Leuvensteijn *et al.* (2011).

57 Van Leuvensteijn *et al.* (2011) estimate a model without the lagged "market share" so that β is their long-term PCS indicator.

58 Bikker (2016a).

59 Creusen *et al.* (2006).

Table 4. The graph starts with fluctuating indicator values during 1995–2002; in 1996, the indicator value was not significantly different from zero, indicating weak competition. In the running-in years to the health insurance reform, the downward trend points to strengthening of competition, reflecting preparation, exactly as in the market share model of Figure 4. In 2006, the year of the health-care insurance reform, competition drops to a lower level, with β moving from -0.74 to -0.49. Reform-induced market turbulences altered the normal marginal cost–net profit relationship. After 2006, competition resumed its regular downward path, except in 2010. The PCS indicator β has a strong downward trend, pointing to increasing dynamic effects of competition on market shares, but its level, in absolute terms, so far remains fairly low.

Figure 5 also shows the annual PCS indicators when the former public NHS institutions are excluded. The results are fairly similar, confirming that the change of health insurance rules and not the introduction of the NHSIs, caused the jump in 2006. Weighted regression results show a similar picture, be it with a larger upward shift in 2006.

Conclusions

This paper investigates the effects of the 2006 health insurance reform in the Netherlands on the market structure, particularly with respect to cost-efficiency and competition, using a unique, non-public data set covering the period 1995–2012. The first measure is unused scale efficiency, which is expected to be low under fierce competition, and the second is the performance-conduct-structure (PCS) indicator of competition, a measurement approach never before applied to the health insurance industry.

For the health insurance industry, we obtain an unused scale economy estimate for the average insurer of 4 per cent for the pre-reform years and 18 per cent to 23 per cent after 2006. An interpretation of this change is that fixed costs increased enormously after the reform, as insurers now have to monitor health-care providers and negotiate lower prices or

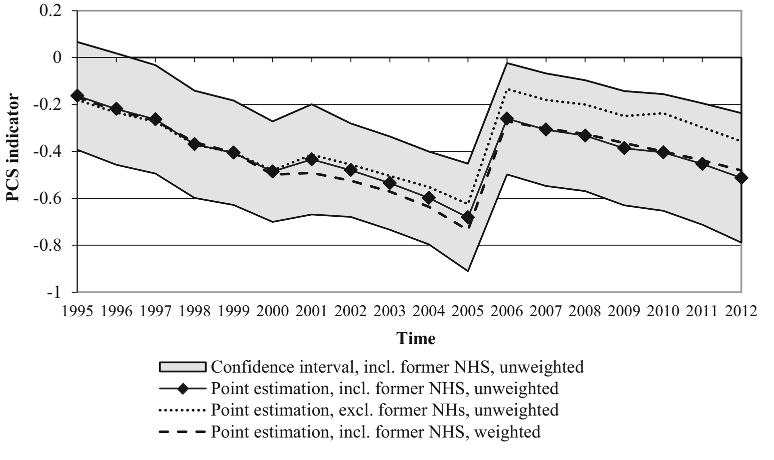

Figure 4. The annual effect of marginal costs on health insurance market shares.

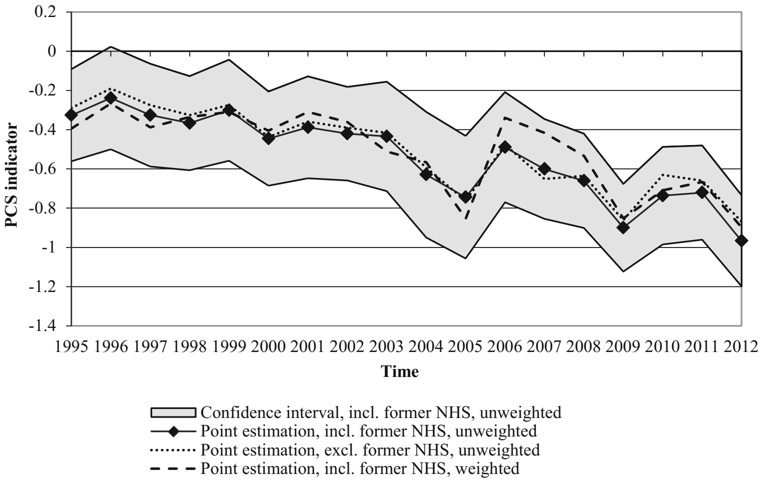

Figure 5. The annual effect of marginal costs on health insurance profits.

higher quality with them. In other words, the optimal scale has increased. Under fierce competition, we do not expect such unused scale economies to persist for long.

Using the PCS indicator of competition for the health insurance market, we observe a significant impact of marginal costs on both market shares and profits, indicating competitive pressure, though less strong than in other financial and non-financial markets. More detailed *annual* estimates of the PCS market share model show that the average competition did fall directly after the reform. Apparently, during the reform-induced market turbulences, the usual marginal cost–market share relationship was less representative. The estimates also reveal a gradual increase of competition both before and since 2006. The impact of marginal costs on profits has been larger after the reform than before, where the impact on market shares is somewhat weaker. Possibly, insurers have focused more on building up solvency buffers (using profits), rather than on competing fiercely on market shares. These outcomes underline that it may take longer before the fruits of the reform in terms of competition and efficiency can be harvested in full. Also, the large observed unused scale economies in health insurance since the reform point to possible efficiency gains that have not yet materialised.

References

Bikker, J.A. and Bos, J. (2008) *Bank Performance: A theoretical and empirical framework for the analysis of profitability, competition and efficiency*. London and New York: Routledge International Studies in Money and Banking.

Bikker, J.A. and van Leuvensteijn, M. (2008) 'Competition and efficiency in the Dutch life insurance industry', *Applied Economics* 40(1): 2063–2084.

Bikker, J.A. and Gorter, J.K. (2011) 'Restructuring of the Dutch nonlife insurance industry: consolidation, organisational form and focus', *The Journal of Risk and Insurance* 78(1): 163–184.

Bikker, J.A. (2016a) 'Performance of the life insurance industry under pressure: efficiency, competition and consolidation', *Risk Management and Insurance Review* 19(1): 73–104.

Bikker, J.A. (2016b) 'Is there an optimal pension fund size? A scale-economy analysis of administrative costs', *The Journal of Risk and Insurance* (forthcoming).

Bikker, J.A. and van Leuvensteijn, M. (2015) *Measuring Competition in the Financial Industry: The Performance-Conduct-Structure Indicator*, London & New York: Routledge.

Boone, J. (2001) 'Intensity of competition and the incentive to innovate', *International Journal of Industrial Organization* 19(5): 705–726.

Boone, J. (2008) 'A new way to measure competition', *The Economic Journal* 118(531): 1245–1261.

Bos, J.W.B. (2004) 'Does market power affect performance in the Dutch banking market? A comparison of reduced form market structure models', *De Economist* 152(4): 491–512.

Choi, B.P. and Weiss, M.A. (2005) 'An empirical investigation of market structure, efficiency, and performance in property-liability insurance', *The Journal of Risk and Insurance* 72(4): 635–673.

Coelli, T.J., Prasada R. and Battese, G.E. (1998) *An Introduction to Efficiency and Productivity Analysis*, Boston/Dordrecht/London: Kluwer Academic Publishers.

Creusen, H., Minne, B. and van der Wiel, H. (2006) *Competition in the Netherlands: an analysis of the period 1993–2001*, CPB Document No. 136, CPB Netherlands Bureau for Economic Policy Analysis, The Hague.

Cummins, J.D., Rubio-Misas, M. and Zi, H. (2004) 'The effect of organizational structure on efficiency: evidence from the Spanish insurance industry', *Journal of Banking & Finance* 28(12): 3113–3150.

Cummins, J.D. and Rubio-Misas, M. (2006) 'Deregulation, consolidation and efficiency: evidence from the Spanish insurance industry', *Journal of Money, Credit and Banking* 38(2): 323–355.

Cummins, J.D, Weiss, M.A., Xie, X. and Zi, H. (2010) 'Economies of scope in financial services: a DEA efficiency analysis of the US insurance industry. *Journal of Banking Finance* 34(7): 1525–1539.

Cummins, J.D. and Xie, X. (2013) 'Efficiency, productivity, and scale economies in the US property-liability insurance industry', *Journal of Productivity Analysis* 39, 141–164.

Cummins, J.D. and Weiss, M.A. (2014) 'Analyzing firm performance in the insurance industry using frontier efficiency and productivity methods', in G. Dionne (ed.), *Handbook of Insurance Economics,* 2nd ed. Boston: Kluwer Academic Publishers, pp. 795–862.

Dafny, L.S. (2010) 'Are health insurance markets competitive?' *American Economic Review* 100(4): 1399–1431.

Daley, C. and Gubb, J. (2011) *Healthcare Systems: The Netherlands.* Civitas, from http://www.digitalezorg.nl/digitale/uploads/2015/03/netherlands.pdf.

Davidson, R. and MacKinnon, J. (1993) *Estimation and Inference in Econometrics.* New York: Oxford University Press.

Dranove, D. and Satterthwaite, M.A. (2000) 'The Industrial organization of health care markets', in A.J. Culyer and J.P. Newhouse (eds), *Handbook of Health Economics*, Vol. 1, Amsterdam: Elsevier Science B.V., pp. 1093–1139.

Eling, M. and Luhnen, M. (2010) 'Efficiency in the international insurance industry: A cross-country comparison', *Journal of Banking & Finance* 34(7): 1497–1509.

Fecher, F., Perelman, S. and Pestieau, P. (1991) 'Scale economies and performance in the French insurance industry', *Geneva Papers on Risk and Insurance – Issues and Practice* 16(3): 315–326.

Fenn, P., Vencappa, D., Diacon, S., Klumpes, P. and O'Brien, C. (2008) 'Market structure and the efficiency of European insurance companies:A stochastic frontier analysis', *Journal of Banking & Finance* 32(1): 86–100.

Gaynor, M. and Town, R.J. (2011) *Competition in health care markets*, NBER Working Paper No. 17208, Cambridge, MA: National Bureau of Economic Research.

Gaynor, M. and Vogt, W.B. (2000) 'Antitrust and competition in health care markets', in A.J. Culyer and J.P. Newhouse (eds), *Handbook of Health Economics*, Vol. 1, Elsevier Science B.V., pp. 1405–1487.

Greß, S., Manouguian, M. and Wasem, J. (2007) *Health Insurance Reform in the Netherlands,* CESifo DICE Report Nr. 1/2007, from http://www.stefan-gress.eu/mediapool/40/403223/data/dicereport107-rm1.pdf.

Hay, D.A. and Liu, G.S. (1997) 'The efficiency of firms: what difference does competition make?', *The Economic Journal* 107(442): 597–617.

Herrick, D.M., (2007) *Medical tourism: global competition in health care*, NCPA Policy Report No. 304, Dallas, TX: National Center for Policy Analysis.

Hirao, Y. and Inoue, T. (2004) 'On the cost structure of the Japanese property-causality insurance industry', *The Journal of Risk and Insurance* 71(3): 501–530.

Hughes, J. and Mester, L. (2013) 'Who said large banks don't experience scale economies? Evidence from a risk-return-driven cost function', *Journal of Financial Intermediation* 22(4): 559–585.

Kasman, A. and Turgutlu, E. (2009) 'Cost efficiency and scale economies in the Turkish insurance industry', *Applied Economics* 41(24): 3151–3159.

Kox, H.L.M. and Van Leeuwen, G. (2011) *Measuring dynamic market selection by persistent scale inefficiencies – new methodology applied to EU business services*, MPRA Paper No. 34986, Munich Personal RePEc Archive, https://mpra.ub.uni-muenchen.de/34986.

Leu, R.E., Rutten, F.F., Brouwer, W., Matter, P. and Rütschi, C. (2009) The Swiss and the Dutch health insurance systems: universal coverage and regulated competitive insurance markets, The Commonwealth Fund, from http://www.commonwealthfund.org/publications/fund-reports/2009/jan/the-swiss-and-dutch-health-insurance-systems–universal-coverage-and-regulated-competitive-insurance.

Mayers, D. and Smith, C.W. (1988) 'Ownership structure across lines of property-casualty insurance', *Journal of Law and Economics* 31(2): 351–378.

Raith, M. (2003) 'Competition, risk, and managerial incentives', *The American Economic Review* 93(4): 1425–1436.

Robinson, J.C. (2004) 'Consolidation and the transformation of competition in health insurance', *Health Affairs* 23(6): 11–24.

Schäfer, W., Kroneman, M., Boerma, W., Van den Berg, M., Westert, G. and Devillé, W. (2010) *The Netherlands: Health System Review*, Health systems in Transition Series No. 12(1).

Swiss Re. (2011) *World insurance in 2010*, sigma Nr. 2, Zurich: Swiss Reinsurance Company Ltd.

Theil, H. (1969) 'A multinomial extension of the linear logit model', *International Economic Review* 10(3): 251–259.

Toivanen, O. (1997) 'Economies of Scale and Scope in the Finnish Non-Life Insurance Industry', *Journal of Banking and Finance* 21: 759–779.

Van den Ven, W.P. and Schut, F.T. (2009) 'Managed competition in the Netherlands: Still work-in-progress', *Health Economics* 18(3): 253–255.

Van Leuvensteijn, M., Bikker, J.A., van Rixtel, A. and Kok-Sørensen, C. (2011) 'A new approach to measuring competition in the loan markets of the euro area', *Applied Economics* 43(23): 3155–3167.

Yang, Z. (2006) 'A two-stage DEA model to evaluate the overall performance of Canadian life and health insurance companies', *Mathematical and Computer Modelling* 43(7–8): 910–919.

Appendix: Data and estimates

Table A1 Estimates of the health insurance cost model based on claims (1995–2012)

	Full period	*Pre-2006*	*Post-2006*
Gross claims (in logs)	0.34***	0.47***	0.31***
Ditto, squared[a]	−0.01	0.02	0.01
Total assets (in logs)	0.46***	0.43***	0.47***
Ditto, squared[a]	−0.11***	−0.13***	−0.01
Cross term GP & TA[a]	0.10***	0.12***	0.01
Real wage (in logs)	0.95**	1.98***	−7.90**
Distribution ratio	1.15***	0.99***	1.16***
HHI/100	0.00	−0.00	0.00
Stock insurers	0.09	0.29***	−0.17**
Time	4.56***	5.29***	−5.08
Constant	0.34***	0.47***	0.31***
Scale economies (SE)	0.20	0.10	0.22
SE, 25th percentile (small insurers)	0.60	0.39	0.23
SE, 50th percentile	0.22	0.14	0.22
SE, 75th percentile (large insurers)	−0.12	−0.14	0.21
Number of observations	1026	659	367
R^2, adjusted (in %)	83.2	85.0	89.0
F test on CRS[b]	67.60***	40.89***	34.51***

Note: See notes to Table 3.

Table A2 Alternative estimates of the health insurance cost model based on premiums (2006–2012, excl. NHSI, unweighted)

	SCFA	*SULF*	*HACD*
Gross premiums (in logs)	0.42***	0.84***	0.46***
Ditto, squared[a]	−0.04**	−0.10**	–
Total assets (in logs)	0.33***	−0.50	0.30***
Ditto, squared[a]	0.02	0.10*	–
Cross term GP & TA[a]	0.02	0.04	–
1/(ln gross premiums)	–	48.35	–
1/(ln total assets)	–	−104.93*	–
1/(gross premiums)	–	–	175.33
Real wage (in logs)	[1]	[1]	[1]
Distribution or acq. ratio	0.98***	1.01***	1.05***
HHI/100	0.00	0.01	0.01
Stock insurers	−0.10	−0.08	−0.10
Time	−0.04**	–	–
Constant	5.85***	10.74***	5.82***
σ_v	0.410	–	–
σ_u	0.513	–	–
Scale economies (SE)	0.25		0.24
SE, 25th percentile (small)	0.35		
SE, 50th percentile	0.27		
SE, 75th percentile (large)	0.15		
Number of observations	271		
Adjusted R^2	–	91.5	91.1
F test on CRS[b]	36.40***		

Note: See notes to Table 3.

Table A3 FE estimates for the non-dynamic health-care PCS model (1995–2012)

	Market share model			*Profit model*		
	Full data set (1)	*Pre-2006 (2)*	*Post-2006 (3)*	*Full data set (4)*	*Pre-2006 (5)*	*Post-2006 (6)*
MC, ln	−0.33***	−0.30**	−0.34***	−0.57***	−0.50**	−1.55***
# of observations	1013	653	360	746	482	264
R^2 overall (in %)	26.5	5.0	42.3	11.8	2.4	14.5

Note: See notes to Table 4.

Table A4 FE estimates for the dynamic health-care PCS model using average costs (1995–2012)

		Market share model			*Profit model*		
		Full data set (1)	*Pre-2006 (2)*	*Post-2006 (3)*	*Full data set (4)*	*Pre-2006 (5)*	*Post-2006 (6)*
AC, ln	β	−0.18***	−0.21***	−0.34***	−0.43***	−0.52**	−1.55***
Market share, lag, ln	γ	0.71	0.69	−0.12	–	–	–
Profits, lag, ln	γ	–	–	–	0.08	0.01	−0.07
Long-term PCS:	$\beta/(1-\gamma)$	−0.63***	−0.69***	−0.31**	−0.46***	−0.53**	−1.45***
# of observations		812	533	279	482	319	163
R^2 overall (in %)		97.4.5	95.9	5.0	15.6	12.6	13.1
R^2 within (in %)		63.5	67.9	15.3	15.6	12.6	13.8

Note: See notes to Table 4.

Table A5 PCS health insurance model estimates over time, based on marginal cost (since 2006 including former NHSI)

	Market shares	*Profit*
1995	−0.16	−0.33***
1996	−0.22*	−0.24*
1997	−0.26**	−0.33**
1998	−0.37***	−0.37***
1999	−0.41***	−0.30**
2000	−0.49***	−0.45***
2001	−0.43***	−0.39***
2002	−0.48***	−0.42***
2003	−0.54***	−0.43***
2004	−0.60***	−0.63***
2005	−0.68***	−0.74***
2006	−0.26**	−0.49***
2007	−0.31**	−0.60***
2008	−0.33***	−0.66***
2009	−0.39***	−0.90***
2010	−0.40***	−0.74***
2011	−0.45***	−0.72***
2012	−0.51***	−0.97***
Time	−0.13***	–
Constant	−10.43***	1.65***
Number of obs.	1031	746
R^2 within (in %)	52.9	17.3
R^2 overall (in %)	4.1	13.8

Notes: Indices *, ** and *** denote significant difference from zero at, respectively, the 90, 95 and 99 % confidence level.

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