Transportation Research Part A 87 (2016) 78–89

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

The effect of contract renewal and competitive tendering on public transport costs, subsidies and ridership

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ARTICLE INFO

Article history:
Received 10 August 2015
Received in revised form 21 November 2015
Accepted 7 March 2016

Keywords:
Public transport
Costs
Regulation
Contract
Tendering

ABSTRACT

In this paper, we aim to estimate the effect of contract renewal as well as competitive tendering on public transport costs, subsidies, and ridership. More specifically, we examine to what extent (multiple) contract renewals and introduction of competitive tendering for long-term public transport contracts affect ridership, operational costs and subsidies in concession areas governed by public transportation authorities from 2001 until 2013 in the Netherlands. Our identification strategy improves on the literature as we are able to control for all time-invariant unobserved factors, such as network and area characteristics by using panel data. We show that when renewing long-term contracts, operational costs are reduced by at least 10%, whereas subsidies fall even stronger. For contracts that are renewed at least twice, the reduction in costs is even more substantial and in the order of 16%. We find that the effect of competitive tendering is completely absent, suggesting that the threat of competitive tendering is sufficient in a market where the majority of concessions is competitive tendered. Contract renewal not only reduces costs and subsidies, but simultaneously increases public transport ridership by 7.7%. Furthermore the vehicle-hours elasticity of operational costs is 0.40, pointing to strong economies of density. The geographical scale elasticity of operational costs is around one, which indicates constant returns to scale with respect to the geographical size of the concession area. This suggest that the current size of the Dutch concession area is optimal with respect to costs.

1. Introduction

After 1990 all over the western world reform of the public transport (PT) industry has taken place. In Europe this reform has intensified due to the EU directive 1191/69/EU that put forward competitive tendering for procurement of exclusive PT services as the preferred way.[1] The new regulative framework for PT aims to enable an efficient and effective transfer of subsidies from the public transport authority (PTA) to operators. A reduction in PT ridership (mainly caused by increasing popularity of the car), combined with universal service obligation, led in the 60s and 70s to increasing operational deficits all over the western world, as fare box revenues increasingly failed to cover operational costs. Public budget constraints forced many Western PTAs to implement regulatory reforms. The new regulatory framework generally aimed to introduce incentives

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[1] The directive is formally finalized with the 2007 Public Service Obligations' Regulation' (later modified by 1893/91/EU). See Van de Velde and Beck (2010).

http://dx.doi.org/10.1016/j.tra.2016.03.003
0965-8564/

for operators to increase efficiency, cut down subsidies and increase social welfare.[2] Triggered by these regulatory changes, a large number of studies have examined the determinants of operational efficiency, and specifically the effect of regulative change on firms' performance. In line with this literature we aim to assess the impact of contract renewal and competitive tendering (CT), on operational costs, subsidy, and PT ridership. We employ panel data for the period 2001–2013 on the level of concession areas in the Netherlands and take the most relevant contract attributes into account.[3]

Our focus on contract renewal is a natural one, as contracts serve as a formal stipulation of arrangements between operators and authorities and govern risk-sharing between PTAs and operators. The role of contract renewal as an incentive driver has long been recognized (Laffont and Tirole, 1993; Dalen et al., 2006; Gautier and Yvrande-Billon, 2013). Contract renewal in a market characterized by CT is pivotal as it allows several operators to bid for a new contract.

One of the main econometric issues is that network characteristics of the concession area impact heavily on PT efficiency, and it is therefore essential to control for (exogenous) relevant network characteristics. Most studies control for variables such as network length, average speed, number of stops and lines, however other network characteristics that may influence firms' productivity cannot be assumed away, thereby potentially biasing the analysis. Our approach avoids this issue by using panel data with concession area fixed effects, thereby controlling for all time-invariant unobserved area circumstances that may influence production efficiency of the firm.[4] To our knowledge we are the first to do this.

In Section 2 we review relevant literature on regulatory change in relation to PT costs and efficiency. Section 3 presents models of PT costs, subsidies, and PT ridership. Section 4 describes the institutional context of PT in the Netherland and presents the data we used. In Section 5 estimation results are given. Section 6 contains conclusions and recommendations.

2. Literature review on regulative change and efficiency in PT

Reform of the PT industry in the western world has led to a large number of studies on PT efficiency and effectiveness. These studies especially focus on how, and to what extent, public sector interventions affect efficiency of, and budget transfers to, PT firms. In this section, we review literature on issues related to competitive tendering, contract type, firm ownership and network characteristics. We also describe the ongoing debate on the most appropriate measure of PT output in the economic analysis.[5]

After the directive 1191/69/EU, CT has become a popular instrument to organize PT in the EU. Its primary aim is reduction of public subsidies. Subsidy reductions come fairly evenly from reductions in factor prices (especially labor and fuel), reductions in the use of labor and land, and adaptions to the production process (Preston, 2002). These efficiency gains are, via sharper contract biddings, transferred from operators to PTAs. Typically, the first round of tendering shows substantial cost reductions up to 50% when PT services were previously provided by public firms under public monopolies, but subsequent re-tendering delivers minimal subsidy reductions (Hensher and Wallis, 2005). Probably the greatest inefficiencies in PT provision are removed as result of the first contract renewal. Further cost reductions are thought to be minimal because the system has matured: authorities and bidders become more experienced (leading to less bid errors), PTAs ask for more demanding contract specifications in subsequent rounds of tendering (such as new low-floor vehicles) and bidders take a longer-term perspective and aim at higher profit margins (Hensher and Wallis, 2005). German urban PT companies operating in areas where CT is implemented reveal a significantly higher average efficiency than other companies (Scheffler et al., 2013). Karlaftis (2010) and Boitani et al. (2013) show with panel data of large European cities in nine different countries that firms selected after CT display approximately a 15–20% higher total factor productivity than firms selected under different contract awarding regimes. To summarize: CT effectively increases firm efficiency, and decreases subsidy transfers by PTAs.

Contract type is a powerful instrument for PTAs to govern transactions with the operator, as contracts make it possible to introduce specific incentives (Margari et al., 2007; Roy and Yvrande-Billon, 2007; Karlaftis and Tsamboulas, 2012; Gautier and Yvrande-Billon, 2013).[6] An important distinction is between high powered fixed price contracts such as gross and net costs contracts and low powered costs-plus, or management, contracts.[7] Under identical network conditions operators regulated by fixed-price contracts are more efficient than operators regulated with costs-plus contracts (Dalen and Gómez-Lobo, 2003; Piacenza, 2006). This implies that the latter contract arrangements especially common in France, are not the most efficient way to reach efficiency goals (Gautier and Yvrande-Billon, 2013). There is empirical evidence that firms under gross costs contracts (where the PTA receives all fare box revenues and therefore bares the commercial risks) are more efficient than firms under net costs contracts (where the operator receives all fare box revenues and bares the commercial risks), as gross costs contracts provides more incentives for production efficiency than net costs contracts. Firms regulated by gross costs contracts solely

[2] For reviews of these phenomena, see various volumes of the THREDBO-series (TREDBO, 2015).

[3] As individual contracts are not publicly available, in our econometric analysis we do not control for all attributes in the contracts. However we control for a range of relevant variables including vehicle kilometres and new vehicles that are usually the main attributes.

[4] This method does not shed light on the influence of individual time-invariant exogenous circumstances on efficiency. We examine this with a separate analysis on the effect of network characteristics on operational costs.

[5] This paper would ideally test the influence of all above mentioned factors on operational costs and ridership empirically. Due to data limitations, the empirical analysis however mainly focuses on competitive tendering, network characteristics and PT output measures.

[6] These studies are based on the (implicit) assumption that the type of contract is exogenous, so independent of the performance and network characteristics. This implies that the type of contract is often determined by political motives, rather than economic ones (Gagnepain and Ivaldi, 2002).

[7] Yardstick regulation is another example of a high powered incentive scheme. It uses benchmarking to reduce the problem of asymmetric information between operator and regulator (Dalen and Gómez-Lobo, 2003).

aim to reduce costs, for example by optimizing the number of drivers and vehicles, whereas firms under net costs contracts also aim to increase revenues (Margari et al., 2007; Gautier and Yvrande-Billon, 2013).[8] We conclude that high-powered incentive contracts (especially gross costs contracts) seem to perform best on efficiency.

According to economic theory, firm ownership matters because public companies tend to be less efficient than private companies, as their deficits are covered by authorities, and may be forced by politicians to hire an inefficient number of workers to boost local employment (Boycko et al., 1996). However, Berechman (1993) and Scheffler et al. (2013), controlling for competition, do not find unambiguous results. Berechman (1993) claims that ownership type is not the determining factor in transit firms' productivity, but rather the size of the transit system and network, as well as the degree of market competition. The majority of frontier studies (especially the parametric frontier studies) show a positive association between private ownership and efficiency, but the results are mixed (see De Borger et al., 2002).[9] Gautier and Yvrande-Billon (2013) and Boitani et al. (2013) find that private operators in France as well as in large European cities are less inefficient than firms governed under mixed public–private ownership. Karlaftis (2010) reports for 15 European cities that public sector operators have 31% higher operating costs than private firms. Karlaftis and Tsamboulas (2012) also show private firms to outperform public firms. We conclude that empirical evidence on efficiency between public and private ownership in the PT sector for the most part favors private ownership, but is not conclusive.

Network conditions are important, so in cost studies economies of scale and density are relevant, but show a wide diversity of outcomes. Robust results however are that firms in small networks produce inefficiently, and scale elasticities decrease as production increases (Croissant et al., 2013). Most studies covered by the meta-study of De Borger et al. (2002) provide evidence for U-shaped marginal costs functions and for economies of density (i.e. returns to traffic density given the network). This holds in the short run (through improved utilization of existing capital stock), as well as in the long run when fleet size can be adjusted (Farsi et al., 2007). Gautier and Yvrande-Billon (2013) show for the French urban PT sector significant economies of scale (0.5 up to 0.7), economies of network length (−0.06 up to −0.12), and economies of network speed (−0.25 up to −0.33). Dalen and Gómez-Lobo (2003), based on panel data for Norwegian bus companies, find strong suggestions of the existence of economies of scale for unregulated long-distance intercity services, which may be connected to higher speed and better utilization of drivers in intercity services. Piacenza (2006) stresses the importance of external network conditions for firms' efficiency, as these conditions often dominate the effects of regulative measures and contractual arrangements. More favorable traffic conditions with higher average speed for PT reduces costs with about 13% up to 36%. Thus, network conditions are a crucial determinant of the efficiency of PT. These conditions are given for the operator and usually correlated to other determinants and type of regulation that are included in the economic analysis. This implies that one has to control for network conditions in order to get a proper assessment of regulatory change on efficiency.

Related to efficiency, few studies report on economies of scope across PT modes. Economies of scope are defined as a situation of change in the unit costs of production in a multi-output production setting, due to the possible use of shared facilities such as management, depots and terminals.[10] Berechman (1993) summarizes the results of (mainly) US studies showing slight economies of scope across modes. Moderate scope economies across modes (around two per cent), and fixed costs reduction due to joint production were also found by Di Giacomo and Ottoz (2010). Economies of scope of 25% were found in a study on Swiss urban PT. These economies decrease with increasing outputs (Farsi et al., 2007).

A fierce debate has been going on concerning the preferred output measurement of PT in efficiency studies (Berechman, 1993; Karlaftis, 2004). Output may be measured in terms of supply, such as vehicle hours or vehicle kilometers, or in terms of demand, such as passenger kilometers or passenger trips.[11] Supply-oriented measures are most popular, but don't reflect the economic motive of PT-supply (De Borger et al., 2002; Brons et al., 2005). On the other hand, demand-oriented measures ignore that input factors such as fuel and labor do not systematically vary with demand. In addition, demand for PT can only be influenced by PT operators to a limited degree (Scheffler et al., 2013). De Borger et al. (2002) conclude that supply oriented parameters are preferred, even given that the firms' objectives using this measure are not taken into consideration.[12] We will use both measures in our application.

3. Estimation methodology

The idea behind implementing competition and regulatory change is based on the assumption that competition favors both efficiency and service quality, thereby leading to costs and subsidy reduction, and to an increase in ridership as demand

[8] Using different methods, Karlaftis (2010) and Karlaftis and Tsamboulas (2012) are among the few that found opposite results.

[9] De Borger et al. (2002) note that most of these studies did not control for level of ownership, degree of competition and the regulatory environment. They argue that for strongly regulated markets like urban transit, ownership itself is of little relevance, but level of competition is.

[10] Economies of scope imply that the average production costs of joint production are lower than the production costs when each of the products is produced separately.

[11] The choice of output measure matters a lot. Berechman and Giuliano (1985) estimate a costs function using a demand related output measure, as well a supply measure, and show increasing returns to scale for the former, and the opposite for the latter.

[12] The firms' objective should be to transport passengers, not to drive buses around. However the regulation practice in large parts of Europe is such that the PTA sets the desired level of production. In these cases it is uncertain whether the firms' goals actually are set in terms of enhancing ridership. This especially applies to gross costs contracts, but may also be relevant in net costs contracts in situations where the firm has little room to maneuver in increasing fare box revenues, as is the case in the Netherlands.

will react positively to increased service quality. We will test for this by estimating models using operational costs, subsidies, and passenger kilometres as dependent variables. We also test whether economies of density and scope exist.

The general specification of the model to be estimated can be written as:

$$Y_{i,t} = Y(X_{i,t}, Z_{i,t}, C_{i,t}, F_s), \quad (1)$$

where $Y_{i,t}$ denotes either operational costs, subsidies or passenger kilometres; X represents a vector of outputs; Z denotes a vector of variables including fixed network, and area inputs; C denotes a vector of contractual issues; F denotes a vector of firm specific issues; subscripts i, t, and s indicate respectively concession area, year, and firm.

One may use several functional forms. A standard log-linear costs model implies a restrictive production function (Berechman and Giuliano, 1985), whereas more general specifications such as the translog form place few a priori restrictions on the underlying production function (Farsi et al., 2007; Roy and Yvrande-Billon, 2007; Scheffler et al., 2013; Croissant et al., 2013). To use the translog function, rather than the log-linear function, is particulary important in a cross-section setting where differences in the dependent variable (costs, subsidies) are substantial. In our application, where we use panel data and focus on yearly changes in the dependent variable between concession areas, these changes are small. Therefore the translog functional form provides essentially identical estimates of the coefficients of interest as a log-linear form. We proceed using the log-linear form, and estimate the parameters using OLS.[13]

Estimates based on panel data are preferred to cross-section data (Croissant et al., 2013). We include year and concession area fixed effects, so all unobserved concession characteristics such as urbanization degree, network length and number of stops which hardly change over time, are taken into account. Appendix A shows that changes in these characteristics are indeed very limited in our data.

3.1. Operational costs, subsidy and passenger kilometres model

In this paper we use the following (log) specification for the operational cost and subsidy model:

$$\ln Y_{i,t} = \beta_0 + \beta_1 CR_{i,t} + \beta_2 CT_{i,t} + \beta_3 NV_{i,t} + \beta_4 NO_{i,t} + \beta_5 \ln VH_{i,t} + \beta_6 MS_s + \delta_t + \eta_i + \varepsilon_{i,t,s} \quad (2)$$

where $Y_{i,t}$ denotes either operational costs, or subsidies in concession area i in year t; $CR_{i,t}$ denotes the number of contract renewals between 2001 and t; $CT_{i,t}$ denotes whether the contract is competitively tendered or negotiated[14]; $NV_{i,t}$ denotes new vehicles in contract; $NO_{i,t}$ denotes a new operator, a proxy for new quality aspects in the contract other than new vehicles; $VH_{i,t}$ denotes vehicle hours; MS_s denotes multi or single-production of the firm; δ_t denotes a year fixed effect; η_i denotes a concession area fixed effect; $\varepsilon_{i,t}$ denotes a random error term. In our data $i = 1, \ldots, 38$; $t = 2001, \ldots, 2013$; $s = 1, \ldots, 15$. We explicitly control for differences in contract characteristics (e.g. new vehicles), for time differences (which captures price effects and changes in technology), and for differences between concession areas (which capture unobserved spatial aspects of concession areas such as network conditions).[15]

We also estimate a model using (log) passenger kilometres as dependent variable. The independent variables are identical to the operational costs model described above:

$$\ln Pax\ km_{i,t} = \gamma_0 + \gamma_1 CR_{i,t} + \gamma_2 CT_{i,t} + \gamma_3 NV_{i,t} + \gamma_4 NO_{i,t} + \gamma_5 \ln VH_{i,t} + \gamma_6 MS_s + \zeta_t + \theta_i + \varepsilon_{i,t,s} \quad (3)$$

where $Pax\ km_{i,t}$ denotes the number of passenger kilometres (ridership).

4. Context and data

4.1. Institutional context

In the 1990s PT in the Netherlands has witnessed a decline of patronage, and increasing public deficits. This induced the Dutch government to change the regulative structure and impose regulative reform. Until 2000 contract were privately awarded to in-house operators. From 2000, competitive tendering was imposed upon regional and local PT concessions in

[13] We have also estimated stochastic costs frontier models for panel data (Kumbhakar and Lovell, 2000; Holmgren, 2013). More precisely, we have estimated a linear model with a disturbance following a Battese-Coelli (1992) parameterization. The inefficiency term is modeled as a truncated-normal random variable multiplied by a specified function of time. Given concession area fixed effects, which control for time-invariant inefficiency, one expects that stochastic frontier models and regression generate very similar results. This is confirmed by our results which show that the variance of the random inefficiency term is only 1.5% of the overall variance. The marginal effects of explaining variables hardly change.

[14] As an alternative to a competitive tendered contract, a contract can be negotiated, indicating the situation where the PTA directly identifies the supplier of the service, imposing or negotiating some conditions.

[15] Factor prices and overall technology change are not explicitly included in the specification, but captured by year fixed effects and concession area fixed effects. In Section 2 we elaborated on the potential important effect of type of contract and firm ownership on operational costs and efficiency. Our data only contains new net costs contract cases. Due to multicollinearity we were not able to test firm ownership empirically. We therefore did not incorporate contract type and firm ownership in the model specifications.

a gradual way.[16] Exceptions were made for the four largest cities areas Amsterdam, Rotterdam, The Hague and Utrecht.[17] Except for Amsterdam, all bus concessions have been competitively tendered at least once. The contracts for metro and tram in The Hague and Rotterdam, and for bus, tram, and metro in Amsterdam are awarded to the 'in-house' operator owned by the municipality. The Utrecht concession was competitive tendered all the same.

A substantial concentration in PT governance and provision has occurred in the last 25 years. During this period the number of PTAs has declined from 56 to 14, the number of concession areas has declined from 74 to 39 and the number of PT-providers has declined from 25 to 10 (KNV, 2015; CROW-KPVV, 2015). Since 2001 foreign companies have acquired all Dutch owned regional bus companies. Except for the municipal firms in Amsterdam, Rotterdam, and The Hague and a firm affiliated to Netherlands Railways, to date there is not a single Dutch bus company left.

The agreements between the PTA and the operator are in most cases put down in net costs contracts in which the operator bears all commercial risk and receives total fare box revenues. As tariffs are governed by the regulators, in practice operators have little room to increase revenues. Contracts can be renewed via competitive tendering (publically awarded contract) or via (re)negotiation with the incumbent operator (privately awarded contract).[18] During the period 2001–2013, our period of study, a contract may change several times (in our data up to three times). Contracts are almost always awarded based on a weighted set of supply oriented output criteria (e.g., number of vehicle hours supplied), and quality criteria (such as new vehicles, interconnectivity, marketing efforts and sustainability). In addition PTAs assess the bids on additional vehicle hours offered. Most PTAs use a best value for fixed subsidy procurement strategy. This implies that PTAs determine a minimum volume of vehicle hours – based on a estimation of market prices – or set a subsidy cap restraint.

4.2. Data collection and definitions

We have collected data by sending a survey to all 18 PTAs. Ten out of 18 PTAs reacted positively and collected annual data on operational costs, vehicle hours, type of contract, contract duration and contract renewal for 38 concession areas for the period 2001–2013. Based on additional sources, we have collected data on the operator in charge, firm ownership, deployment of new vehicles, passenger kilometres, number of stops and network length (CROW-KPVV, 2015; KNV, 2015; Zwart, 2012).[19] The sample appears representative for the Netherlands and contains small and large, as well as urban and rural concessions. For some years, some PTAs were not able to provide information, so we have unbalanced panel data. For the main specification, we have 301 complete observations.

We use structural expenditures on PT operations to measure costs.[20] We do not observe these expenditures directly, but these can be derived from the subsidy from the PTA to the operator and the operators' fare box revenues which are both reported. Given the assumption that the operators' profit margins are small, operational costs approximately equal to the sum of subsidies and fare box revenues.[21] Descriptives of the main variables of interest are shown in Tables 1 and 2. In Table 1, we present descriptives on operational costs, vehicle hours and passenger kilometres. In Table 2 we focus on contract renewals.

4.3. Descriptives

Table 1 shows that annual operational costs per concession area is about € 32 million, with a subsidy ratio of about 50%, average annual subsidy per concession area is € 14 million. Annual vehicle hours per concession is about 280,000 and annual ridership is about 116 million passenger kilometres.[22] Table 1 shows considerable standard deviations for these variables, due to differences in the size of the concession areas, but annual changes in these variables are small which justifies our log-linear approach.

Table 2 shows that in the period under study, 61 contract were renewed. 69% of these were renewed after a process of competitive tendering of which about half were awarded to a new operator. The majority of contract renewals results in introduction of new vehicles. After renewal 24% of the concession areas are operated by a publicly owned firm and 44% by a multi-product firm that operates both bus and metro/tram/light train. Concerning type of contract the situation in the Netherlands is such that the majority of contracts that is renewed after 2001 is of the net costs-type. Our sample contains only net-cost contract renewals.[23] Although we do not have specific information on contract type, before 2001 most contracts

[16] Most train services were exempted.

[17] It was argued that public transport in these areas is provided as integrated networks of bus, tram and metro, and that ownership structure of infrastructure and rolling stock is complex and may form barriers to market entrance.

[18] This applies to the contracts in the three largest cities and to contracts in the first phase of the new regulation, as legislation allows for exceptions for CT in the first years.

[19] Data on passenger kilometres are hard to get, as data collection on PT demand is not uniformed, definitions change during time, and data collection is very costly. This especially hold for obtaining time series and panel data on PT demand. We collected passenger kilometres for the period 2001–2011 on PTA level from an external source (Zwart, 2012), and adapted the data in order to obtain a complete as possible picture of the developments in PT demand. The adaption protocol is available on request.

[20] This measure does not contain infrastructural expenditures, maintenance costs, infrastructure levies and incidental operational expenses.

[21] An additional argument which justifies our approach to measure costs is that ownership of PT firms usually is foreign, so profits (or losses) do not affect Dutch welfare.

[22] Due to definition changes, the data on passenger kilometres are less reliable for some areas which changed from ticketing system during the period studied.

[23] So we cannot empirically test the effect of contract type.

Table 1
Descriptives on financial performance.

	Number of observations	Mean	Std. deviation
Operational costs (€ × 1000)	301	31,625	35,302
Annual change operational costs (€ × 1000)	265	915	3,026
Vehicle hours	332	283,432	241,503
Annual change vehicle hours	294	4,480	31,763
Passenger km's (×1000)	363	115,969	103,786
Annual change passenger km's (×1000)	330	553	9,909
Subsidies (€ × 1000)	350	14,319	15,698
Annual change subsidies (€ × 1000)	311	−63	2508

Table 2
Descriptives on contract renewal.

	Number of observations	%
Renewed once	15	25
Renewed twice	40	66
Renewed three times	6	10
Renewed via competitive tendering	42	69
New operator and competitive tendering	22	36
New vehicles	31	51
No new vehicles	19	31
New vehicle unknown	11	18
Contract awarded to multi-product firm	27	44
Contract awarded to publicly owned firm	15	24

were gross costs contracts. So, probably most of the first contract renewals in our sample are from a gross costs to a net costs contract, and therefore the results show the combined effect of first contract renewal and change of contract type. Subsequent contract renewals are always from net costs to net costs contracts. CT is implemented in the Netherlands in phases. This implies that not all contract are competitively tendered directly after 2001. However, once a contract is competitively tendered, also subsequent contract renewals are performed under competitive tendering. For 9 contracts in our sample we are also able to assess the effect of change from a negotiated (privately awarded) contract to a CT contract.

5. Results

5.1. Operational costs, subsidies, contract renewal, and tendering

In Table 3 the main results are provided for several specifications of the operational costs model (specifications 1 thru 4) and for a specification using subsidies as dependent variable (specifications 5 and 6). In all specifications, we include number of contract renewals, competitive tendering, log vehicle hours, year and concession area fixed effects.[24] Importantly, by including concession area fixed effects we improve on existing studies as we are able to control for time-invariant area related unobserved variables (e.g., residential density). In Appendix C we show the results of two pooled OLS analyzes in which the area fixed effect are excluded, and show that excluding these fixed effects result in extremely biased coefficients.

The results of the most basic Specification (1), imply that contract renewal leads to a substantial reduction in operational costs. When a contract is renewed at least once, costs fall by 10%. Contracts renewed at least twice even lead to an extra costs reduction of 6%, so a total reduction of 16%. A third contract renewal seems to reduce operational costs even further, but this effect is statistically not significant at conventional significance levels, probably due to the small number of observations referring to three renewals (see Table 1). These results imply that the effect of contract renewal is diminishing; the first time a contract is renewed yields the greatest operational costs reduction. This finding is in line with previous studies (Hensher and Wallis, 2005; Preston and Almutairi, 2013). We do not find evidence that there is an effect of competitive tendering on operational costs, suggesting that the threat of CT is sufficient in a market where the majority of concessions is competitive tendered. The estimated coefficients of (log) vehicle hours show that considerable economies of density exist within concession areas.[25] The costs elasticity of density is about 0.40, i.e. if production volume on a given networks is increased 10%, costs

[24] The year fixed effects, not presented here but available on request, show an annual autonomous 3.8% growth of operational costs. This growth reflects increases in input prices for the operator (e.g., wages, gasoline prices, bus prices). So the identified effects of contract renewal are not due to market developments in input prices.

[25] Network size remains largely constant in the concession areas (see Table 1), so it is more appropriate to interpret this result as economies of density rather than economies of scale. We emphasize that the model specification (1) does not allow for comparisons of economies between concession areas, only within these areas. To assess optimal size of concession areas, in Section 5.3 we further elaborate on economies of density between concession areas.

Table 3
Operational costs and subsidies.

	(1) Costs	(2) Costs	(3) Costs	(4) Costs	(5) Subs.	(6) Subs.
Contract renewed minimal once	−0.105*** (0.025)	−0.092*** (0.026)	−0.088*** (0.025)	−0.057** (0.027)	−0.198** (0.079)	−0.229*** (0.078)
Contract two or three times renewed	−0.061** (0.019)	−0.064*** (0.019)	−0.060*** (0.019)	−0.048** (0.019)	−0.208*** (0.060)	−0.241*** (0.059)
Contract three times renewed	−0.037 (0.046)	−0.039 (0.048)		0.017 (0.049)	0.346** (0.150)	
Contract competitively tendered	0.016 (0.024)	−0.006 (0.033)	−0.009 (0.033)	−0.032 (0.033)	0.144 (0.104)	0.172* (0.104)
New operator		0.081*** (0.023)	0.079*** (0.023)	0.067*** (0.023)	0.118** (0.069)	0.135** (0.069)
New vehicles unknown		−0.032 (0.035)	−0.038 (0.034)	−0.042 (0.034)	−0.031 (0.108)	0.014 (0.107)
Partly new vehicles		−0.015 (0.034)	−0.015 (0.034)	−0.037 (0.033)	−0.082 (0.103)	−0.084 (0.104)
All new vehicles		−0.031 (0.033)	−0.029 (0.033)	−0.015 (0.032)	−0.189* (0.102)	−0.207** (0.102)
Vehicle hours (log)	0.425*** (0.052)	0.446*** (0.054)	0.445*** (0.054)	0.379*** (0.056)	0.222 (0.160)	0.234 (0.161)
Single product firm				−0.085*** (0.021)		
Year fixed effects (13)	Yes	Yes	Yes	Yes	Yes	Yes
Concession area fixed effects (38)	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	301	301	301	301	325	325
R^2	0.997	0.997	0.997	0.9975	0.970	0.9695

Note: specifications (1) thru (4): dependent variable is logarithm of operational costs, specification (5) and (6) dependent variable is logarithm of subsidies. Standard errors between brackets.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

increase by 4%. Economies of density are often found in empirical studies on network industries such as transportation (see, for instance, Berechman and Giuliano, 1985; De Borger et al., 2002; Farsi et al., 2007; Gautier and Yvrande-Billon, 2013).

In specification (2), we have added two additional variables to capture changes in the terms of the contracts by including new operator (as proxy for quality aspects in the contract) and new vehicles dummies. It appears that the effects of contract renewal and CT hardly change. In case the CT procedure leads to a new operator, PTAs are willing to pay 8% more compared to the situation the incumbent stays in charge. This effect is unlikely induced by differences in factor input prices between operators, as all bidders (new and incumbents) have to abide legislation, and act under the same conditions.[26] Our explanation for this finding is that, within the boundaries of a subsidy cap set by the PTAs, new operators perform better on quality criteria compared to the incumbent, although their costs are higher than the incumbents'. We do not find evidence that there is an effect of new vehicles on operational costs.[27] One possible explanation is that vehicle costs are only a small part of operating costs (for bus exploitation about 15–20%, see Koolen and Stoelinga, 2005). Moreover, operators don't own the fleet, but lease the vehicles and have a return arrangement with the lessee. Gautier and Yvrande-Billon (2013) reach similar results, as they show that bus fleet age hardly impact costs. As the number of contracts three times tendered is very small, we have excluded this variable in specification (3). The results hardly change, so we may conclude that this variable does not add to the specification.

Economies of scope across modes may occur when firms supply bus as well as tram/metro (in a certain year). In our sample, the (municipal) firms in Amsterdam, Rotterdam and The Hague supply both bus, and tram/metro. Furthermore, a number of other firms provide bus and light train services, but not necessarily in the same concession area. To examine economies of scope, we distinguish between multiple and single product firms. Multi-product firms supply both bus and rail

[26] These result indicate regulatory schemes and operators' efficiency levels are exogenous, and that the operators information level about its technology, and its efforts to reduce costs are greatly unobserved by the PTA. Therefore the theory of regulation under asymmetric information may apply to the PT industry in the Netherlands (see Laffont and Tirole, 1993; Gagnepain and Ivaldi, 2002).

[27] The data for the new vehicle variable originates from additional data sources and are likely of lower quality than those based on our questionnaire, so it is likely that the variable 'new vehicles' has measurement error. In general, if an explanatory variable has (random) measurement error, than the estimated coefficient is biased toward zero, which may explain these results.

either within the same concession area or in an adjacent concession area. Otherwise, a firm is defined as a single-product firm. In this way we are able to differentiate between concession areas operated by single-product or multi-product firms.[28] Specification (4) of Table 3 shows that controlling for single/multi-product firms reduces the effect of contract renewal somewhat (by about one third). Furthermore, we do not find evidence for positive economies of scope. To the contrary, the results indicate diseconomies of scope; multi-product firms have 8.5% higher costs than single-product firms. Multi-product firms seem to be less cost efficient than single-product firms. This implies that in case PTAs aim to procure multi-modal PT services and restrict providers to multi-product firms, the change is they have to pay more subsidies than if they split procurement by mode, in that way making also bids possible from specialized single-product firms.[29] Our results are in line with Di Giacomo and Ottoz (2010), who also report diseconomies of scope across bus and rail modes, but are not in line with Farsi et al. (2007) who find economies of scope. Finally note that we do *not* control for the size of the firm. If it is true that the size of firms is systematically related to whether a firm is a single or multiproduct firm, then our results will be biased.

One may expect the effect of contract renewal on subsidies is more pronounced than on operational cost as the average subsidy to operational costs ratio is about 50%. As shown in specification (5) of Table 3, contracts that are renewed at least once induce a 20% fall in subsidies. An additional contract renewal leads again to a 20% subsidy reduction. Contracts three times renewed shows an opposite – subsidy-increasing-effect, possibly because only two contracts in our sample are three times renewed. As we did in specification (3), in specification (6) we also excluded contracts three times renewed. Again, the results hardly change.

As mentioned above we control for all unobservable time-invariant spatial and network effects by using concession areas dummies in our models. Previous cross-section studies use specific control variables (Farsi et al., 2007: number of stops, Karlaftis, 2010: network length, Boitani et al., 2013: GDP per capita, Gautier and Yvrande-Billon, 2013: network length and speed, Piacenza, 2006: commercial speed, Karlaftis and Tsamboulas, 2012: area surface, population density, Margari et al., 2007; average commercial speed, population density, Sakai and Takahashi, 2013, average route length, Scheffler et al., 2013: population density, network length). These empirical studies indicate that many factors determine operational costs, so that it seems merely impossible to capture all possible individual influences using cross-sectional data, and results therefore will be easily biased.

To demonstrate the importance of including area fixed effects, we have also estimated the model without these fixed effects (a so called ‘pooled OLS’), see Appendix C. We find that the results are extremely biased. This also occurs when one controls for network variables such as the number of lines and stops and the degree of urbanization. For example the results in these specifications erroneously indicate that the first round of contract renewal leads to an increase in operational costs. These results are clearly biased because the identification of the parameters of interest is based on cross-sectional variation in the data.[30]

In Section 2 we discussed the question of the most appropriate output measure for public transport efficiency. Should PT output be defined in demand, or in supply parameters? In Appendix B – using a slightly smaller set of observations – we report results when using passenger kilometres and vehicle hours as output measure. It appears that the coefficient for passenger kilometres is not significant, indicating the influence of ridership on operational costs is absent and using a supply oriented measure for PT performance seems therefore the most appropriate.[31] As is common in these types of models, the R^2 of all models is (very) high, because variation over time in the dependent variable, given the year fixed effects, is limited, as the area fixed effects capture most cross-sectional variation. Importantly however, the value of the R^2 is unrelated to the question whether coefficients are consistently estimated.

5.2. Passenger kilometres, contract renewal, and tendering

We aim to test now the hypothesis that contract renewal and CT may work out favorable on PT quality and provision, and therefore may enhance ridership, using the logarithm of number of passenger kilometres as dependent variable. The results are shown in Table 4.

Our results indicate a significant positive effect of contract renewal on (log) passenger kilometres. Renewing a contract results in a 7.6% increase in passenger kilometres. A second contract renewal leads to an additional 4.0% increase in passenger kilometres, so contracts that are renewed at least twice induce an 12% increase in passenger kilometres. Further, there is no effect of CT and new operator. The vehicle hours elasticity of demand is small (equal to 0.17). Hence, a 10% increase in vehicle hours leads only to a 1.7% increase in passenger kilometres. Similar results are found in many other studies (see e.g. Goodwin, 1992; Holmgren, 2007; Currie and Wallis, 2008).

[28] For convience we assume firms to be in one group for the whole of the contract duration.In reality the latter will not always be true as mergers and acquisitions did occur especially during the period 2007–2011.

[29] However, if not from a cost perspective, from a consumer perspective multi-modal concessions may be preferred, as interchanges between bus and rail can be better organized.

[30] As a sensitivity analysis, Specification (3) in Appendix C includes concession area fixed effects and network variables. It shows that adding 10% more stops to a network results in 2% higher costs. Note that the variable grade of urbanization is omitted in this model as this variable is time-invariant.

[31] In Section 2 we also indicated firm ownership may be of influence on operational costs. We tried to assess the effect of a change of ownership of the firm, however, due to multicollinearity, we were not able to estimate the appropriate function. We may however indicate we control our models for the effect of new ownership.

Table 4
Passenger kilometres.

Contract renewed min once	0.076*** (0.030)
Contract two or three times renewed	0.043* (0.025)
Contract competitively tendered	−0.028 (0.032)
New operator	−0.040 (0.026)
Logarithm of vehicle hours	0.173*** (0.060)
Year fixed effects (13)	Yes
Concession area fixed effects (38)	Yes
Number of observations	270
R^2	0.997

Note: dependent variable log passenger kilometres.
Standard errors between brackets.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

5.3. Size of concession areas

Viewed from a policy as well as from an economic perspective, the geographical size of concession areas governed by public transport authorities is of interest (De Borger et al., 2002; Farsi et al., 2007; Croissant et al., 2013). In the Netherlands, after the first round of tendering, this size has sharply increased, which raises the question what is the economic rationale for this concentration drive. As Croissant et al. (2013) frame it: is allotment a useful strategy for PTAs? The idea of geographical allotment is not only relevant in economic theory, but also in governance and institutional theory. The latter assumes that regulation and transaction costs in larger areas may be less than in smaller ones. On the other hand, dividing the network in smaller lots may increase competition, and yield a better market/social outcome.

To analyze concession area size, we estimate a between-area fixed effects model, and analyze economies of scale controlling for time-invariant area specific differences such as urban density, network characteristics (number of lines and stops) and PT mode on operational costs.[32] In this way, we compare concession areas which each other using the – over the years-average values of variables. As the differences between costs and production levels between concession areas are substantial, we now use a translog flexible functional form, with vehicle hours as dependent variable.[33] We allow for production heterogeneity (some firms produces multi-products; i.e. bus and rail) by including a PT mode dummy in the specification.

$$\ln OC_i = \alpha + \beta_q(\ln Q_i - ln\bar{Q}_i) + \frac{1}{2}\beta_{qq}(\ln Q_i - \ln\bar{Q}_i)^2 + \beta_d \ln D_i + \beta_l \ln L_i + \beta_s \ln S_i + \beta_m M_i + \varepsilon_i \quad (4)$$

where OC denotes operational costs, i denotes a concession area, m denotes mode, Q denotes production in vehicle hours, $\bar{Q}$ denotes production of sample mean, D denotes urban density of the concession areas measured as number of inhabitants per hectare build-up area, L denotes number of lines, S denotes number of stops, M denotes a mode dummy, and ε_i denotes the standard error term.

In Table 5, the descriptives per concession area are given for bus and rail separately. It appears that in terms of costs and vehicle hours, mean values of bus and rail are of similar order of magnitude, indicating that controlling for PT mode using a dummy indicator in (4) is not problematic. The results of model (4) are shown in Table 6.

These results indicate PT in the Netherlands is produced under a situation of constant economies of scale: the effect of log vehicle hours is 1.165 but not significant different from one where the square of log vehicle hours is essential zero.[34] If any economies exist, slight diseconomies of scale are most probable. This implies that concessions areas – whether big or small- are of optimal size, and operational costs cannot be reduced by changing the size of the concession area by geographical allotment.

6. Conclusions and policy implications

In this paper, we have estimated the effects of regulatory change on operational costs, subsidies and ridership. We contribute to existing literature by using a panel dataset that makes it possible to control for all unobserved time-invariant net-

[32] In the previous section we showed that economies of density within concession areas exist using within fixed effects. This does however not imply that larger concession areas perform better than smaller. Therefor in this section we estimate between-area fixed effects.
[33] The translog functional form is a second order approximation to an arbitrary costs function. We use the sample mean as the approximation point.
[34] We also performed separate analyzes for bus and rail. We found very similar results.

Table 5
Descriptives per concession area.

	Bus			Rail		
	N	Mean	Std. deviation	*N*	Mean	Std. deviation
Operational costs (€ × 1000)	24	24,388	19,716	9	39,200	49,666
Vehicle hours	26	327,258	224,902	9	179,704	270,286
Urban density	26	33.6	13.0	12	38.7	14.8
Number of lines	26	30.4	19.9	11	3.7	5.0
Number of stops	26	929.3	625.8	11	107.7	194.4

Note: mean values per area, price level 2000.

Table 6
Economies of scale (between-area fixed effects).

Vehicle hours (log)	1.165*** (0.140)
1/2 vehicle hours (log)^2	−0.009 (0.059)
Urban density (log)	−0.242 (0.222)
Bus	0.632* (0.326)
Number of lines (log)	−0.238 (0.206)
Number of stops (log)	0.025 (0.159)
Constant	17.838*** (1.078)

Note: 38 concession areas.
Standard errors between brackets.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

work and area characteristics. We show that contract renewal substantially reduces operational costs as well as subsidies and increases ridership. We also found strong economies of density within networks, constant returns to geographical scale and diseconomies of scope across PT modes. Based on our results one may conclude that the policy of the Dutch administration, which aims to increase efficiency and ridership in the PT sector by means of competition, is successful. Contract renewal under a CT regime leads to decreasing subsidies, and increasing ridership. Our results are however not conclusive. We find that the immediate effect of competitive tendering is absent, suggesting that the threat of CT is sufficient in a market when the majority of concessions are competitive tendered. To study the aspect of threat of competition in more detail is therefore useful, for instance by detailed analyses of the content, procedures, and political pressure exerted concerning publicly awarded contracts. Our economies of scale results indicate that the geographical size of the current concession areas may not be altered without additional costs. From an operational costs perspective, our study suggests that there is no reason to increase (or decrease) the geographical size of concession areas.

PTAs have an important role setting the network conditions over which the PT services are performed, therefore, besides regulatory policies as discussed in the current paper, PTAs should develop and implement infrastructural policies. If network conditions become to unfavourable, even under a competitive tendering regime, costs and subsidy effects of contract renewal may run out. Therefore PTAs should also focus on sustaining excellent network conditions, thereby aiming at increasing free flow for the PT system. Finally, our analyses focus on costs, subsidies and ridership only. Therefore we cannot assess total welfare effects of regulatory change. We for instance did not analyze transaction and monitoring costs, which may be substantial, changes in level-of-service, fare increases and external effects. To assess the overall effects of regulatory change in the Netherlands, one needs a comprehensive social welfare analysis (see Preston and Almutairi, 2013; Hensher and Wallis, 2005; Gagnepain and Ivaldi, 2002).

Acknowledgements

We would like to thank regional authorities who provided us with the necessary data and were always willing to answer additional questions and seminar participants of the ITEA conference in Oslo in June 2015 who commented on earlier drafts.

Table A
Network characteristics of concession areas.

Year	Mean number of lines	Mean number of stops
2003	23	700
2004	22	693
2005	22	687
2006	22	675
2007	22	665
2008	22	674
2009	24	700

Table B
Sensitivity analysis on the choice of output measure of PT performance.

	Costs
Contract renewed minimal once	−0.091***
	0.027
Contract two or three times renewed	−0.055**
	0.022
Contract competitively tendered	0.023
	0.026
Logarithm of vehicle hours	0.407***
	0.056
Logarithm pax km's	−0.044
	0.084
Year fixed effects (13)	Yes
Concession area fixed effects (38)	Yes
N	245
R^2	0.998

Note: dependent (log) operational costs.
Standard errors between brackets.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table C
Additional analyzes.

	(1) Costs	(2) Costs	(3) Costs
Contract renewed minimal once	0.416***	0.247**	−0.094***
	(0.114	(0.114	(0.033
Contract two or three times renewed	−0.018	0.057	−0.051*
	(0.082	(0.114	(0.030
Contract three times renewed	−0.162		
	(0.289		
Contract competitively tendered (1) vs. privately (0) awarded	−0.713***	−0.407***	0.007
	(0.084	(0.105	(0.037
ln # lines		−0.427***	−0.099
		(0.110	(0.064
ln # stops		0.089	0.195***
		(0.085	(0.073
ln grade of urbanization (in h/ha)		0.000	n.a
		(0.137	
Logarithm of vehicle hours	0.713***	1.051***	0.446***
	(0.026	(0.078	(0.078
Year fixed effects (13)	Yes	Yes	Yes
Concession area fixed effects (38)	No	No	Yes
N	301	175	175
R^2	0.844	0.889	0.997

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

In particular we would like to thank Carl Koopmans and Marc Ivaldi and two anonymous reviewers who provided us with useful suggestions.

Appendix A

See Table A.

Appendix B

See Table B.

Appendix C

See Table C.

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