Audit Market Concentration and Regulatory Reforms

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Abstract

The audit market is characterized by a high level of concentration which regulators around the world regard as unsatisfactory. Improving the competitive situation is one of the aims of the recent regulatory reforms. In this paper we consider some of the recent reforms and argue that they are likely to increase, rather than decrease, the level of market concentration. To prove this we show that the audit market has the nature of a "natural oligopoly" (Shaked & Sutton 1983). We derive conditions under which reforms such as liability caps, minimum quality requirements, and joint audits have the opposite effects to what is intended.

Disclaimer: This is incomplete work in progress. Do not post this on the web. COMMENTS ARE WELCOME.

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1 Introduction

The audit market is characterized by a split of the audit firms in Big 4 and non-Big 4 audit companies. In 2016, the Big 4 auditors, PricewaterhouseCoopers, KPMG, Ernst&Young and Deloitte, covered a total market share of 61 percent in the European Union\(^1\). For the S&P 500 companies, the total market share of the Big 4 auditors reaches even a level of 99.4 percent in 2017\(^2\). As a response, recent years have witnessed increasing regulatory activities regarding the audit market. The high level of market concentration is commonly seen as a major driver for several risks of the global financial system. Thus, the EU Commission (2017) states

"One of the Regulation’s main aims is to have a competitive market for statutory audit services in which there is a sufficient choice of statutory auditors or firms for [public-interest enterprises].”

The EU has taken several steps to increase competition and reduce the systematic risk for statutory audits. For instance, since 2016 (audit directive 2006/43/EC), a new legislation applies that, among many other elements, aims at increasing the minimum quality for statutory audits through the introduction of the International Standards on Auditing. This applies to all statutory auditors, joint with other elements that have less influence on market shares, like organizational requirements to increase auditor independence,
tighter requirements regarding the information content of auditor reports.³

This reform is the most recent one of a series of other attempts. Other examples are the recommendation of the European Commission of 2008, introducing the possibility to cap the liability of a statutory auditor.⁴ In 2010 the discussion on joint audits started in the European Commission. The European Commission suggested a mandatory joint audit requirement in the green paper of 2010.⁵ Later, in 2011, the European Commission published the proposal for the amendment of the directive 2006/43/EC and softened the approach to a recommendation for joint audits.⁶ The final amendment of the directive extends the maximum period for external audit firm rotation from 20 years to 24 years, if a joint audit is applied.⁷

In this paper we develop an analytical model to investigate the impact of three regulatory reforms, limiting liability, increases of minimum audit standards, and joint audits on market concentration. We show that concentration is naturally caused by the specific characteristics of the audit market. We derive this result from two assumptions: auditors are differentiated with respect to audit quality, and better audit quality increases ceteris paribus the expected share value of the clients.

Given these two assumptions, if audit fees were equal across all audit

³There are also specific requirements for auditors of public interest entities like mandatory firm rotation, restrictions on non-audit services for audit clients, increased responsibility of the audit committee regarding the oversight of the auditor, and increased transparency in audit reports.


⁵https://eur-lex.europa.eu/procedure/EN/199744

⁶https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012XX1106(01)&from=EN

suppliers, potential clients would unanimously prefer to hire the best auditor in the market and auditors of lower quality would have to exit. The market would assume maximum concentration. This extreme thought experiment highlights the reformers’ dilemma. Increasing competition in the audit market reduces the dispersion of fees which tends to increase, rather than decrease concentration. The same result would apply if all auditors had the same quality: Bertrand competition would drive fees down and the eroded profit margins would force all but one auditor to exit. We conclude that for a less concentrated equilibrium we need a set of auditors that have differentiated qualities where low-quality auditors charge lower fees than high quality auditors.\(^8\)

Presumably more in order to ensure trust in the auditing industry rather than in order to influence market structure, the International Auditing and Assurance Standards Board (IAASB) defines audit standards (the International Standards on Auditing - ISA). Most regulatory authorities and exchanges, in particular the European Commission, require that large companies appoint auditors that apply the ISA. Hence, the EU countries have at least two different levels of audit qualities: In accordance to Article 21 of the directive 2014/56/EU, member states have to ensure that auditors of large and public interest firms meet the ISA for statutory audits. However there

\(^8\)In the language of Industrial Economics these assumptions cause ”vertical product differentiation” (Gabszewicz and Thisse 1979; Shaked and Sutton 1983). As we explain further below, market mechanics in this family of product differentiation models starkly differs from models of ”horizontal product differentiation” like the famous Hotelling model. In a horizontal product differentiation model customers would buy from different companies at hypothetical identical prices which leads to dispersion rather than concentration (Tirole 1988, Chapter 7).
is also a lower level: regulation of statutory audits of small firms is delegated to the local authorities of the member states.

We assume that quality differentials are imposed by audit standards that are defined by the regulator. Most legislations know a variety of standards. For instance, Switzerland knows three layers. The lowest segment is given by ”Certified Auditors”, the middle segment by ”Licensed Audit Experts” and the highest segment by ”Auditors Under State Oversight”.

The Federal Audit Oversight Authority (FAOA) determines the requirements to receive the specific certificate and is also responsible for the supervision of the maintenance of the requirements. The requirements differ regarding education and yearly trainings of the auditor as well as the internal review and control processes. The highest requirements are defined to become an audit firm under state oversight. Companies observe the certificate of each auditor. Based on the certificate, companies can determine the expected audit quality. A similar practice can be observed by the Public Company Accounting Oversight Board (PCAOB). There, audit firms have to register if they issue audit reports for public companies. On a risk-based approach PCAOB inspects registered audit firms and issues a public report of the results.

Given this quality differential, our main results are obviously driven by the fact that shareholders ceteris paribus benefit from higher audit quality. We derive this property from the assumption that higher audit quality translates into a higher probability of identifying and silently removing accounting errors before publication of a financial report. This reduces the ex post risk
that such errors are discovered by either regulatory authorities, or the press, or the market where those latter discoveries are costly in the sense that the share price erodes and destroys shareholder value.

We then show that marginal audit costs that are sufficiently flat in the standard turn the audit market into a "natural oligopoly", as coined by Shaked and Sutton (1983). A "natural oligopoly" is a market where the number of firms in equilibrium remains bounded, even when market entry costs get arbitrarily small, or the market gets arbitrarily big. Notice that such markets differ radically from the usual paradigm in oligopoly theory where, as entry costs tend to zero, the number of firms that can survive in equilibrium goes to infinity (like in the classic Cournot model or the classic Hotelling model). Following Shaked and Sutton (1983), the latter is impossible for markets with vertical product differentiation if the marginal cost of providing the audit service is sufficiently flat in quality. Intuitively, if very many firms were to enter such a market, prices would converge to marginal cost. However, if marginal costs are sufficiently flat in quality, all clients would demand services from the highest-quality provider, thus leaving all other providers with zero market shares. Hence, no equilibrium exists where very many auditors survive in the market.

We then consider three recent regulatory measures that were introduced with the intention to reduce concentration in the audit market, namely, restricted auditor liability, increased minimum audit qualities, and joint audits. Within the framework of our model, we demonstrate how all three measures tend to increase, rather than decrease, the equilibrium concentration in the
audit market.

To gather the intuition for our results, consider the effects from limiting auditors’ liability first. Restricting auditor liability allows audit firms to reduce insurance costs for bigger clients. Hence, the variable cost of providing the audit service is reduced. However, in our equilibrium, more profitable clients contract with auditors of higher quality. Hence, as argued above, if the variable cost of providing the audit service for more profitable clients goes down decreasing fees of the best auditor also attracts less profitable clients. Hence, properties of the ”natural oligopoly” become stronger. This reduces the market shares of lower-quality auditors. In effect, reducing auditor liability has a detrimental effect on market concentration.

Second, raising minimum audit quality leads to tougher competition between the lower and the middle tier of the audit market. We show that this erodes profit margins of all tiers because audit fees are strategic complements. The increased price competition harms all auditors, but if the marginal cost of providing the audit service is sufficiently flat in quality, the lowest-quality auditor is hit most. It is easy to derive conditions that he cannot survive in the market.

Finally, we model joint audits. As part of the recent reform in the EU, companies are allowed to appoint two auditors that are supposed to issue a joint audit reports. As it is prohibitively difficult to embed all possible details and incentive conflicts of such an arrangement, we take a very stylized approach and assume that the resulting quality of the joint audit is a convex combination of the individual audit qualities. This results in more qualities
offered in a market where the number of firms that can survive in equilibrium is bounded. As a consequence, the lowest quality firms may be forced to leave the market and concentration increases.

Different from our approach, in most parts of the auditing literature, audit quality is endogenous and the result of an act of ex post moral hazard. For instance, Ewert and Wagenhofer (2016) analyze the impact of an increase in enforcement effectiveness on the quality of reporting. They show that stronger enforcement does not necessarily increase reporting quality. In our model, there is no such strategic interaction.

A key characteristic of our model is that higher-quality auditors earn higher audit fees and are appointed by more profitable firms and gather higher audit fees. Thus, we complement to a literature that focuses on the interaction between audit quality and audit premia. Corona and Randhawa (2010) show that the auditor does not always deliver a better audit quality, given a higher auditor reputation. Moser (2016) models the auditors’ incentives to signal their reputation and explains why a lower audit quality might be offered under certain conditions. A lower audit quality can increase the probability of getting the audit mandate. In Datar and Alles (1999) the auditor type is unobservable. Reputation is formed endogenously by the interaction between the auditor and the manager of the firm and impacts future relations between the auditor and the manager. The authors highlight that reputational concerns of the auditor let the latter keep the audit quality at a high level despite of reduced liability.

Our model assumptions and the results are consistent to several empirical
papers:

Skinner and Srinivasan (2012) analyze an accounting fraud case in Japan in 2006 and argue that larger firms need the reputation of the audit firm more than smaller firms and thus larger firms are more eager to switch the auditor related to the considered accounting fraud. Complementary to that we assume that firms with higher earnings are more willing to select an auditor with a high audit quality than firms in the lower earnings segment.

Other empirical research considers the determinants of audit fees. Regarding the Big N audit premium, there is mixed evidence. This literature focuses on the main audit fee determinants. Lawrence et al. (2011) highlight the relation between client characteristics and the differences in the audit quality proxies for Big 4 and non-Big 4 audit companies. Client size explains the differences in the proxies for audit quality. Craswell et. al (1995) capture the industry specialization of the auditor company in addition to the reputation of the auditor and analyze their impact on the audit fees for publicly listed firms in Australia. They are able to identify a Big 8 audit premium over non-Big 8 audit companies. This difference increases if industry specialist Big 8 auditors are compared to nonspecialist non-Big 8 audit firms. We complete the picture of the existing empirical literature by providing an analytical structure and explaining the existence of higher audit fees of the high quality auditors by the vertical product differentiation structure of the audit market. Other than that, Simons and Zein (2016) model the role of mid-tier auditors with regard of the average audit quality level and competition in the audit market. Their model builds on a Hotelling-approach and lets them
compare a market with three auditor types to a market with two auditor types. The auditors flexibility to adjust to the customer’s audit profile plays a central role and the total audit costs are directly linked to the distance between the offered audit quality and the clients audit profile. They conclude that the mid-tier auditor can increase the overall average audit quality under certain circumstances. On the other hand, standard setters should focus on a similarity of auditor flexibility between mid-tier and first-tier audit firms.

The remainder of the paper is organized as follows. In the next section we introduce the model. Section 3 contains the main analytical analysis and the key results. In Section 4 we finally consider the impact of recent regulatory reforms on the equilibrium. A few conclusions follow in the last section.

2 The model

There is a continuum of firms, each with a true fundamental value of (net) assets $x$, uniformly distributed on the interval $[y, z]$. Let $S$ be a parameter for the market size such that for each $x$ the total mass of firms with value less than $x$ equals $S(x - y)/(z - y)$.

The accounting system of each firm produces a preliminary report $\pi$. With probability $p$ the report contains a mechanical error $e$, i.e. $\pi = x + e$. With probability $(1 - p)$ the report is free from error and $\pi = x$.

The shareholders observe $\pi$, but not the true value of $x$. Based on $\pi$ they select an auditor.
There are $n$ auditors $i$ in the market, each characterized by an audit quality $q_i$ that we normalize between zero and one. Without loss of generality, we order the auditors such that $1 \geq q_1 \geq q_2 \geq \ldots \geq q_n \geq 0$. Given the quality certification we assume that the $q_i$ are common knowledge. Each auditor has a variable cost of providing the service $c(q_i)$. We assume that $c$ is linear in quality: $c(q_i) = \alpha q_i$ where $\alpha \geq 0$ represents the slope. For computational convenience, we choose the example of $n = 3$.

Each auditor charges an audit fee $F_i$. Shareholders observe all $F_i$ and select their auditor. After being appointed, auditor $i$ observes the true value of $x$ with probability $q_i$ and eliminates the error $e$ if present. Thus, if the auditor observes $x$, the final report is $r = x$. If the auditor does not observe $x$, the final report is $r = \pi = x + e$.

In the latter case, a market control authority observes the true value of $x$ with probability $\gamma$. We assume that the firm’s shares become worthless if it turns out that $\pi \neq x$.

Before we proceed to the analysis, we will consider the distribution $h(\pi)$ of preliminary firm profits closer. This distribution is defined over the interval $[y, z + e]$ and stepwise with

$$h(\pi) = \begin{cases} 
1 - p & \text{for } \pi \in [y, y + e) \\
\frac{1}{z+e-y} & \text{for } \pi \in [y + e, z] \\
\frac{p}{z+e-y} & \text{for } \pi \in (z, z + e] 
\end{cases}$$

Notice that if $\pi$ falls below $y + e$, the error can be excluded for sure. Firms located below $y + e$ don’t need an auditor. The "auditor" for these

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9This is an extreme assumption that could be relaxed. Any reduction in shareholder value below $x$ would work.
firms at best has a statutory role. To simplify our language and exposition, we therefore define

**Definition 1** If an audit company has just clients in the lower subinterval \([y, y + e]\), we define his market share as Nil.

Due to the stepwise distribution of preliminary earnings \(\pi\), our analysis is potentially plagued by case distinctions that are not illuminating. To avoid this we restrict attention to a particular convenient parameter combination that is derived in Lemma 2 below. The condition states that in equilibrium each auditor has clients in the middle segment of the earnings interval. In addition we need the technical assumption that the error is not too big, i.e. \(e < y/(1 - p)\).

### 3 Equilibrium and market concentration

We solve the game by backward induction and derive the equilibrium audit fees first. Based on \(\pi\), the shareholders select the auditor, forming an expectation over the price. The middle interval is of special interest. If the shareholders obtain a preliminary report \(\pi \in [y + e, z]\), they know that \(\pi\) is correct with probability \(1 - p\). Moreover, with probability \(pq_i\) the auditor will correct the error. With probability \(p(1 - q_i)(1 - \gamma)\) the final report includes the undetected error, but the market forms rational expectations and corrects for it. Finally, with probability \(p(1 - q_i)\gamma\) the shares are worthless.
To shorten notation we define

\[ u_i = pq_i + p(1 - q_i)(1 - \gamma) \]

and write the expected share price in the middle case as

\[ E[P | \pi] = [(1 - p) + u_i](\pi - F_i) - u_ie. \]

Consider a shareholder that receives a preliminary report \( \pi \in [y + e, z] \). The shareholders prefer auditor \( i \) over \( i + 1 \) if

\[ [(1 - p) + u_i](\pi - F_i) - u_ie \geq [(1 - p) + u_{i+1}](\pi - F_{i+1}) - u_{i+1}e \]

Assuming the indifferent firm is within the middle interval \([y + e, z]\), a firm with a preliminary report \( \pi \) prefers auditor \( i \) over auditor \( i + 1 \) if and only if

\[ \pi \geq \bar{\pi}_{i+1} = e + \frac{F_i u_i - F_{i+1} u_{i+1} + (F_i - F_{i+1})(1 - p)}{u_i - u_{i+1}} \]

We assume for a while that the fees \( F_i \) are such that \( y + e < \bar{\pi}_3 < \bar{\pi}_2 < z \) and state a sufficient condition later. Given this assumption, market shares are given by

\[
M_3 = \int_{y}^{y+e} S \frac{1 - p}{z + e - y} d\pi + \int_{y+e}^{\pi_3} S \frac{1}{z + e - y} d\pi \\
M_2 = \int_{\pi_3}^{\pi_2} S \frac{1}{z + e - y} d\pi \\
M_1 = \int_{\pi_2}^{z} S \frac{1}{z + e - y} d\pi + \int_{z}^{z+e} S \frac{p}{z + e - y} d\pi
\]
Given these market shares, variable profits for auditor $i$ are given by
$(F_i - c(q_i))M_i$ from which we may derive the best response functions for
the audit fees $F_1, F_2, F_3$, which is a system of 3 linear equations with three
unknowns. The calculation of the best response functions is presented in the
Appendix.

**Lemma 1** Assuming that all $\pi_i$ are between $y + e$ and $z$ and variable audit
costs are linear in quality, $c(q_i) = \alpha q_i$, the equilibrium prices are $F_1^*, F_2^*, F_3^*$
where

\[
F_1^* = \frac{\alpha q_1}{2} + \frac{(u_1 - u_2) \left( \frac{F_2^*(u_2 + 1 - p)}{u_1 - u_2} + (e(-1 + p) + z) \right)}{2(u_1 + 1 - p)}
\]

\[
F_2^* = \frac{2\alpha q_2}{3} + \frac{\alpha q_1(u_1 + 1 - p)(u_2 - u_3) + (u_1 - u_2)(\alpha q_3(u_3 + 1 - p) + (u_2 - u_3)(z - y))}{3(u_2 + 1 - p)(u_1 - u_3)}
\]

\[
F_3^* = \frac{\alpha q_3}{2} + \frac{(u_2 - u_3) \left( \frac{F_2^*(u_2 + 1 - p)}{u_2 - u_3} + (e(1 - p) - y) \right)}{2(u_3 + 1 - p)}
\]

From these audit fees we can derive the market shares.

**Proposition 1** Suppose three auditors can survive in equilibrium with posi-
tive market shares and quality levels $q_3 < q_2 < q_1$. Moreover, let $c(q_i) = \alpha q_i$
and all $\pi_i$ between $y + e$ and $z$. Under a uniform distribution of $\pi$ with all
\(\pi_i\) between \(y + e\) and \(z\) equilibrium market shares are given by

\[
\frac{M_3^*}{S} = \frac{\alpha [3(1 - p\gamma) + p\gamma(q_1 + 2q_2 + 3q_3)]}{6p\gamma(z + e - y)} + \frac{(z - y)(q_1 - q_2) - 3y(q_1 - q_3) + 3e(1 - p)(q_1 - q_3)}{6(q_1 - q_3)(z - y + e)}
\]

\[
\frac{M_2^*}{S} = \frac{z - y + \alpha(q_1 - q_3)}{3(z - y + e)}
\]

\[
\frac{M_1^*}{S} = -\frac{\alpha(3 + p\gamma(3q_1 + 2q_2 + q_3 - 3))}{6p\gamma(z - y + e)} + \frac{(3e(p - 1)(q_1 - q_3) - y(q_2 - q_3) + z(3q_1 + q_2 - 4q_3))}{6(q_1 - q_3)(z - y + e)}
\]

Before we proceed, we should insert a technical step and make sure that no indifferent firm \(\pi_i\) is in the upper or lower ends of the preliminary reports interval, \([y, y + e]\) or \((z, z + e]\). This avoids not illuminating case discussions. To this end we have to place assumptions on the exogenous parameters of the model. The conditions are stated in the following Lemma. We assume that these parameter values hold throughout the analysis.

**Lemma 2** The above prices yield \(y + e < \pi_3 < \pi_2 < z\) if

\[
y < \frac{F_2^*u_2 - F_3^*u_3 + (F_2^* - F_3^*)(1 - p)}{u_2 - u_3}
\]

and

\[
z > \frac{F_1^*u_1 - F_2^*u_2 + (F_1^* - F_2^*)(1 - p)}{u_1 - u_2} + e.
\]
To ease the exposition, we derive the central result for an extreme case, namely, that the variable cost of providing the audit service is constant in quality \((\alpha = 0)\). In this case we obtain

\[
\frac{M_3^*(\alpha = 0)}{S} = \frac{(z - y)(q_1 - q_2) - 3y(q_1 - q_3) + 3e(1 - p)(q_1 - q_3)}{6(q_1 - q_3)(z - y + e)}
\]

\[
\frac{M_2^*(\alpha = 0)}{S} = \frac{z - y}{3(z - y + e)}
\]

\[
\frac{M_1^*(\alpha = 0)}{S} = \frac{(z - y)(q_2 - q_3) + 3z(q_1 - q_3) - 3e(1 - p)(q_1 - q_3)}{6(q_1 - q_3)(z - y + e)}
\]

which reveals that, independent of the market size \(S\), the market share of the third auditor vanishes if the diversity of firm values \(z - y\) is sufficiently small.

Referring to Definition 1 above we will say that auditor 3 has lost its market if \(M_3^*/S\) has dropped below the share that is obtained by just serving the lowest subinterval of firms between \(y\) and \(y + e\). Recall that these firms don’t need an auditor for other than statutory purposes.

The market share obtained by just serving the lowest subinterval is given by \(e(1 - p)/(z - y + e)\). \(M_3^*/S\) drops below this value if

\[
z < \frac{y(4q_1 - q_2 - 3q_3) + 3e(1 - p)(q_1 - q_3)}{(q_1 - q_2)}
\]

Thus we obtain

**Proposition 2** Suppose that variable cost are constant in audit quality \((\alpha = 0)\). A necessary condition for auditor 3 to survive in equilibrium is that firm
values are sufficiently diverse, i.e.

\[ z \geq \frac{y(4q_1 - q_2 - 3q_3) + 3c(1 - p)(q_1 - q_3)}{(q_1 - q_2)}. \]

Proposition 2 is the key to the central results. It is well established in vertical product differentiation models (e.g. Gabszewicz & Thisse 1979 or Shaked & Sutton 1983). If the variable cost of providing the audit service is sufficiently flat in quality, the lowest quality auditor gets squeezed out of the market if the diversity of firm values becomes sufficiently low. As this result holds independent of the market size \( S \), this property is in stark contrast to "standard" results in oligopoly theory where the number of firms that enter the market tends to infinity as market size goes to infinity.\textsuperscript{10} The boundedness result also holds independent of the exact qualities \( q_i \) of the auditors.\textsuperscript{11}

If the condition of Proposition 2 is violated, the number of auditors in the market is bounded by \( n^* = 2 \). If \( z \) is bigger, a number greater than 2 would survive, but again, the new maximum number would be independent of market size. The striking result is due to the assumption on marginal audit costs that are constant in the audit quality \( q_i \). As shown by Shaked & Sutton (1983), a necessary condition for the boundedness property not to hold is that \( \alpha \) is sufficiently high.

In what follows we abstain from welfare implications of the model. Rather we take it for granted that a regulator has the aim to reduce concentration.

\textsuperscript{10} Had we modeled market entry costs and free market entry, the analogous result would hold if entry costs go to zero.

\textsuperscript{11} That is, it also holds in a free-entry model with optimal choices of the \( q_i \).
To this end, we investigate the effects of those recent regulations for the audit market that were designed to achieve this goal.

4 Regulatory reforms

4.1 Liability caps

Even before the disappearance of Arthur Andersen it was apparent that audit firms face life threatening litigation risks. Hence, auditors spend significant amounts to insure themselves against these risks. In 2008, the EU commission recommended to limit auditors’ liability. In a memo (EU Commission 2008) it justifies the recommendation as follows

"In the light of the current audit market structure, liability risks arising from the increasing litigation trend combined with insufficient insurance cover may deter auditors from providing audit services for listed companies. If these structural obstacles (liability risks/lack of insurance) persist, mid-tier audit firms are unlikely to become a major alternative to the "Big 4" audit networks on European capital markets." (emphasis by the authors).

In the light of our above results we may investigate this claim in the framework of our model. We start from the assumption that insurances charge higher premiums for audit clients with greater profitability. As the profitable clients contract with the high-quality auditors, a liability cap essentially translates into a reduction of slope of variable costs, $\alpha$. 
Departing from Proposition 1, the comparative statics is straightforward.

**Proposition 3** Suppose that a liability cap reduces the slope of variable audit cost in quality, \( \alpha \). Departing from a situation where three auditors survive in the market, concentration increases, in that auditor 1 gathers a higher and auditors 2 and 3 have a reduced market share.

\[
\frac{\partial M_3}{\partial \alpha} = S \cdot \frac{3 + \gamma p(q_1 + 2q_2 + 3q_3 - 3)}{6\gamma p(z + e - y)} > 0
\]

\[
\frac{\partial M_2}{\partial \alpha} = S \cdot \frac{q_1 - q_3}{3(z + e - y)} > 0
\]

\[
\frac{\partial M_1}{\partial \alpha} = -S \cdot \frac{(3 + \gamma p(3q_1 + 2q_2 + q_3 - 3)}{6\gamma p(z + e - y)} < 0
\]

We conclude that liability caps tend to reduce the market shares of smaller auditors and increase market shares of bigger auditors. Moreover, as a Corollary of Proposition 2, if regulation drives \( \alpha \) down sufficiently, the low-quality segment of auditors is even driven out of the market. Obviously, the reform has the opposite effect to what was intended.

### 4.2 Minimum audit quality standards

As an example of a Non-EU country, consider Switzerland. Three types of auditor admission levels exist. The lowest level is the "Certified Auditor" in accordance to the Audit Oversight Act (AOA) Art. 5.\(^{12}\). The middle level,

\(^{12}\)https://www.admin.ch/opc/de/classified-compilation/20032757/index.html
in accordance with AOA Art. 4, is the admission as Certified Audit Expert. The highest quality level with the highest level of supervision is, in accordance with AOA Art. 8, the admission as audit firm under state oversight. In accordance with AOA Art. 16a, the Federal Audit Oversight Authority (FAOA) is responsible for the definition of audit standards. The standard is defined in the FAOA Circular 1/2008 and has been revised in 2013. The swiss audit standard (PS) contains 44\textsuperscript{13} new and revised standard. In addition, the swiss quality assurance standard 1 (QS 1) was introduced. Similar to the international standard on quality control 1 (ISQC 1)\textsuperscript{14} introduced in 2009 and the quality control standard of the PCAOB (QC PCAOB)\textsuperscript{15} introduced in 2003, the QS 1 defines requirements for the responsibility of the quality of services within audit firms, the code of conduct for auditors, rules with respect to the acceptance and continuance of client relationships as well as processes for supervision during and review after the audits.

We consider the consequences of this approach in the framework of our model by assuming that the regulator requires a minimum quality level. Of course, if this level is not binding, the consequences are nil. Moreover, as we do not work with endogenous quality choices in our model, it may happen that, for given locations $q_2$ and $q_1$, our exogenous position of auditor 3 is lower than the best-response position, given that all three survive in market equilibrium. In this case, "forcing" auditor 3 to move up $q_3$ increases its profit (but reduces those of auditors 1 & 2). Naturally, the opposite happens.

\textsuperscript{13}https://www.expertsuisse.ch/dynasite.cfm?dsmid=508822&page=2
\textsuperscript{14}http://www.ifac.org/system/files/downloads/a007-2010-iaasb-handbook-isqc-1.pdf
\textsuperscript{15}https://pcaobus.org/Standards/QC/Pages/default.aspx
if regulation forces auditor 3 to move to a quality level $q_3$ that is higher than the best response level.

**Proposition 4** Suppose the actual quality offered by auditor 3 is a best response given the qualities $q_1$ and $q_2$. Departing from this situation, an increase in the minimum quality requirements, represented by an increase of $q_3$ decreases the market share and decreases the variable earnings of auditor 3.

\[
\frac{\partial M_3}{\partial q_3} = -S \cdot \frac{\alpha (q_1 - q_3)^2 + (q_1 - q_2)(z - y)}{6(q_1 - q_3)^2(z + e - y)} < 0
\]

\[
\frac{\partial M_2}{\partial q_3} = -S \cdot \frac{\alpha}{3(z + e - y)} < 0
\]

\[
\frac{\partial M_1}{\partial q_3} = S \cdot \frac{3\alpha (q_1 - q_3)^2 + (q_1 - q_2)(z - y)}{6(q_1 - q_3)^2(z + e - y)} > 0
\]

\[
\lim_{q_3 \to q_2} \Pi_3 = 0
\]

This result is not especially due to the nature of the market as a vertically differentiated market. Rather, it would hold in a similar way for a horizontal product differentiation model. The intuition is that moving auditors closer intensifies competition in fees and erodes profit margins. If the initial quality of auditor 3 is a best response to the quality of auditor 2, the auditor 3 is worse off after the reform, not better off. In the presence of non-sunk fixed auditing costs (which are not modeled here) this may trigger market exits at the lower end of the quality interval.
4.3 Joint audits

Following the 2016 EU reform, firms may appoint more than one statutory auditor or audit firm. The appointed auditors present a joint audit report to the audited entity and bear the full responsibility for the audit. Joint audits have many aspects that cannot be addressed by our parsimonious model. In particular, moral hazard issues emanating from the arising team problem will emerge that need to be addressed in more fine-tuned modeling approaches. We just concentrate on the main objective, assuming away these problems. To quote the EU commission\textsuperscript{16}:

"Mid-tier audit firms (i.e. those who are not members of the largest networks) will benefit from the reform as new market opportunities emerge. Mandatory rotation, together with the incentives for joint audit and tendering, as well as the prohibition of certain non-audit services to audit clients - requiring de facto that another audit firm provides these services - are examples of measures that should make the market more dynamic and ultimately less concentrated."

Our modeling approach is admittedly very stylized. In our example, two types of auditors exist. Again we assume that each auditor $i$ commits to an audit quality level $q_i$ and each auditor announces an audit fee $F_i$. In our example, we consider a high auditor H and a low auditor L. With two auditors

\textsuperscript{16}https://europa.eu/rapid/press-release_MEMO-16-2244_de.htm
we end up with two market segments, divided by an earnings thresholds \( \bar{\pi} \).

Thus, without joint audits this would yield the following market shares for the high auditor H and low auditor L:

\[
M_H = \int_{\pi}^{z} S \frac{1}{z + e - y} d\pi + \int_{z}^{z+e} S \frac{p}{z + e - y} d\pi \\
M_L = \int_{y}^{y+e} S \frac{1 - p}{z + e - y} d\pi + \int_{y+e}^{\pi} S \frac{1}{z + e - y} d\pi
\]

With the possibility of joint audits the firms now additionally have the option to hire a team of two auditors that share the audit task. Auditor H receives the portion \( w \) and auditor L the other portion \( (1 - w) \) of the mutual market share. Thus, the factor \( w \) represents the engagement weight of auditor H and \( (1 - w) \) the engagement weight of auditor L, where \( 0 < w < 1 \). The resulting combined quality level is \( q_M = wq_H + (1 - w)q_L \) and the firm pays the joint audit fee \( F_M = wF_H + (1 - w)F_L \).

In our two-auditor example we end up with three market segments, divided by two earnings thresholds \( \bar{\pi}_2 \) and \( \bar{\pi}_3 \). At the lowest tier, firms just appoint the low auditor L. This is followed by some subinterval of firms that appoint both auditors H and L jointly, followed by a subinterval of firms that just appoint high auditor H. The intuition for the new results is simple: consider a marginal situation where \( \alpha \) is sufficiently flat and the disparity of firm values is sufficiently low such that the low auditor L just survives in the market. Introducing joint audits in the above manner introduces additional competition. When setting the new fee, each auditor is aware that in the new setting the joint audit is in competition against the own single audit offer. To
reduce this "externality" there is an incentive to increase the fees. However, each neighbor comes closer which intensifies competition with others. This creates an incentive to reduces fees. The net effect of the introduction of a joint audit on the audit fees depends on several factors.

Based on the earnings thresholds $\bar{\pi}_3$ and $\bar{\pi}_2$ and the equilibrium audit fees $F^*_H$ and $F^*_L$ after joint audits, we obtain the following market shares:

$$M_{HJA} = w \int_{\pi_3}^{\pi_2} S \frac{1}{z + e - y} d\pi + \int_{\pi_2}^{\pi_3} S \frac{1}{z + e - y} d\pi + \int_{z}^{z+e} S \frac{p}{z + e - y} d\pi$$

$$M_{LJA} = \int_{y}^{y+e} S \frac{1 - p}{z + e - y} d\pi + \int_{y+e}^{\pi_3} S \frac{1}{z + e - y} d\pi + (1 - w) \int_{\pi_3}^{\pi_2} S \frac{1}{z + e - y} d\pi$$

If we assume a weight $w = \frac{1}{2}$ of the better auditor, which corresponds to the situation where both auditors are equally engaged in the audit process, the market shares after the introduction of joint audits remain the same. However, an unequal weighting combination is often observable: an established and bigger auditor is leading the joint audit, while smaller single tasks are delegated to the smaller auditor. Le Maux (2004) claims that the joint audits in France lead to joint audit constellations where the big auditor takes up to 98 % of the audit fees of the joint audit. In our model, this is represented by a higher engagement $w$ of the better auditor $H$. Hence we assume an engagement weight of $w > \frac{1}{2}$ of auditor $H$. By comparing the market shares before and after the introduction of joint audits, we observe that the market share of high auditor $H$ increases while the market share of low auditor $L$ decreases after the introduction of joint audits, given an engagement weight of $w > \frac{1}{2}$ of auditor $H$. 

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As a consequence, joint audits only reduce the market share of the better auditor H and hence the market concentration, if the smaller auditor is more engaged in the joint audit than the better auditor. In practice this corresponds to the situation where the smaller auditor leads the joint audit, which we doubt to be a realistic scenario.
5 Conclusion

In this paper we have suggested vertical product differentiation as a paradigm for the audit market. We investigated a number of recent regulatory measures that have been introduced to reduce the concentration in the audit market. We have shown that in a market with vertical product differentiation these regulations tend to be counter-productive.

Our model shows that concentration is a natural result in the audit market. Building on established results by Gabszewicz and Thisse (1979) and Shaked and Sutton (1982, 1983), if the variable audit cost is sufficiently flat in the level of audit quality, a "natural oligopoly" arises. The number of auditors that enter the market is bounded, even if the market becomes large or the entry cost goes to zero. In such a situation, any attempt to intensify competition will squeeze the lowest quality auditors out of the market and let concentration increase.

A situation with arbitrarily many firms in the market will arise only if the variable cost of providing audit service is sufficiently strongly increasing in the level of audit quality. However, even then, competition will be limited, as firms are widely differentiated.

In our model, differences in audit quality arise solely from the ex ante commitment to audit standards that we leave exogenous. While it is conceivable that one could solve a model with endogenous quality choices with sufficiently brute force, this extension would suffer from limited tractability without adding too much to the insights. Obviously there are many more
steps to be done, like modifying fee formation or adding moral hazard on both the auditor and the client side. However, whatever the modeling changes are, as long as firms unanimously agree that they ceteris paribus prefer higher audit quality to lower audit quality, it appears questionable if increasing the competitive nature of the audit market will ever reduce the concentration in the market.
Appendix

Best response functions of the audit fees:

\[
F_3 = \frac{c(q_3)}{2} + \frac{(u_2 - u_3) \left( \frac{F_2(u_2+1-p)}{u_2-u_3} + (e(1-p) - y) \right)}{2(u_3+1-p)}
\]

\[
F_2 = \frac{c(q_2)}{2} + \frac{F_1(u_1 + 1 - p)(u_2 - u_3) + F_3(u_3 + 1 - p)(u_1 - u_2)}{2(u_2 + 1 - p)(u_1 - u_3)}
\]

\[
F_1 = \frac{c(q_1)}{2} + \frac{(u_1 - u_2) \left( \frac{F_2(u_2+1-p)}{u_1-u_2} + (e(-1 + p) + z) \right)}{2(u_1 + 1 - p)}
\]

Optimal audit fees as described in Lemma 1:

\[
F_1^* = \frac{\alpha q_1}{2} + \frac{(u_1 - u_2) \left( \frac{F_2^*(u_2+1-p)}{u_1-u_2} + (e(-1 + p) + z) \right)}{2(u_1 + 1 - p)}
\]

\[
F_2^* = \frac{2\alpha q_2}{3} + \frac{\alpha q_1(u_1 + 1 - p)(u_2 - u_3) + (u_1 - u_2)(\alpha q_3(u_3 + 1 - p) + (u_2 - u_3)(z - y))}{3(u_2 + 1 - p)(u_1 - u_3)}
\]

\[
F_3^* = \frac{\alpha q_3}{2} + \frac{(u_2 - u_3) \left( \frac{F_2^*(u_2+1-p)}{u_2-u_3} + (e(1-p) - y) \right)}{2(u_3 + 1 - p)}
\]
Market shares as described in Proposition 1:

\[
\frac{M_3}{S} = \frac{\alpha(3 + p\gamma(3q_3 + 2q_2 + q_1 - 3))}{6p\gamma(z + e - y)} \\
\qquad \quad + \frac{(3e(1 - p))(q_1 - q_3) - y(4q_1 - q_2 - 3q_3) + z(q_1 - q_2))}{6(q_1 - q_3)(z + e - y)}
\]

\[
\frac{M_2}{S} = \frac{\alpha(q_1 - q_3) + z - y}{3(z + e - y)}
\]

\[
\frac{M_1}{S} = \frac{-\alpha(3 + p\gamma(3q_1 + 2q_2 + 3q_3 - 3))}{6p\gamma(z + e - y)} \\
\qquad \quad + \frac{(3e(p - 1))(q_1 - q_3) - y(q_2 - q_3) + z(3q_1 + q_2 - 4q_3))}{6(q_1 - q_3)(z + e - y)}
\]

Boundaries for $y$ and $z$ to avoid not illuminating case distinctions:

\[
\bar{y} = \frac{(q_1 - q_3)(3e\gamma(p - 1)p + \alpha(3 + p\gamma(q_1 + 2q_2 + 3q_3 - 3)) + p\gamma(q_1 - q_2)z}{p\gamma(4q_1 - q_2 - 3q_3)}
\]

\[
\bar{z} = \frac{(q_1 - q_3)(3e\gamma(1 + p) + \alpha(3 + p\gamma(3q_1 + 2q_2 + 3q_3 - 3)) + p\gamma(q_2 - q_3)y}{p\gamma(3q_1 + q_2 - 4q_3)}
\]
References


