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Literature Review "Audit Production"

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Practice Summary

How can the economics of auditing be described?

When we refer to the economics of auditing, we are referring to two factors. The first factor is the supply of auditing, which covers the inputs and their associated costs to produce an audit. The second factor is the demand for auditing, which covers the preferences of client-firms and investors for different types of audits. In this study, we focus on the supply side given the sparse literature on the production of audits and the rich data that FAR might eventually provide.

Why is it important to understand the economics of auditing?

Given that auditing provides assurance for the financial statements provided to investors, it is important to understand the incentives and costs of producing such assurance, which help facilitate capital investment.

What do we already know about audit production?

The auditing literature has explored audit supply from four main perspectives: (1) *the effort perspective*, which investigates and generally finds that audit effort (audit hours) is associated with measures of audit quality; (2) *the efficiency perspective*, which investigates what characteristics of the engagement, client, or market influence relative efficiencies across audit engagements; (3) *the productivity perspective*, which investigates aggregate productivity changes of the audit industry over time; and (4) *the learning perspective*, which investigates whether efficiencies occur through learning in service settings.

What do we still need to know/learn?

We have limited knowledge about differences in productivity and learning across auditors. Further, we do not understand how auditor skills combine with technology in order to produce audits. This is especially important given the shift by audit firms toward using machine learning and big data techniques.

Production function estimates would allow us to characterize and model the supply side of the audit market, opening up a host of new analyses. Examples of such investigations include evaluating productivity growth in the audit industry, characterizing differences in productivity and learning across auditors / audit teams, examining the relationships between productivity growth and changes in audit technologies and the use of technology, testing whether more efficient auditors are rewarded by the market, measuring to what extent fee variation reflects differences in costs, and (given additional information on inputs into non-audit services) estimation of the extent of knowledge spillovers—positive or negative—of non-audit services on the provision of audit services. Many of these analyses would be novel in the accounting and auditing literature and would also add much needed depth to the broader productivity and industrial organization literatures, which have had limited contact with the business services sector.

What can practitioners/regulators do with that knowledge?

That knowledge could assist practitioners in improving and transitioning their production processes toward technology given the tight labor market for auditors and would inform the current public debate with regards to the future structuring of the auditing profession (e.g., audit quality metrics).

Literature Review

Production is the process by which inputs are transformed into outputs through factors of production. In the case of an audit, audit effort (labor and time) is expended to produce assurance over client financial statements (O'Keefe, Simunic, and Stein 1994). As is typical for services, labor is the most important factor in the production of audits. Although audit production is crucial to understanding the economics of auditing, the literature on audit production is sparse due to the difficulty of observing and measuring the factors of production. Specifically, the lack of access to internal audit firm information makes it difficult for researchers to observe and measure production inputs. Moreover, the credence good nature of an audit makes it difficult to observe audit output (i.e., the level of assurance).

Prior research relies on the conceptual framework of O'Keefe, Simunic, and Stein (1994), which assumes that the level of assurance is constant for a certain audit firm and that client or engagement characteristics determine cross-sectional differences in inputs. They specify that the auditor firm's objective function is to minimize labor hours for a given client's characteristics. Empirical research on audit production relies on their model and examines the relation between client characteristics and the number of labor hours expended by various types of labor in the audit firm (i.e., audit output). This literature on audit production is summarized below in the *Effort* section.

A related stream of literature has used non-parametric estimation techniques to assess relative efficiencies across audit engagements. This literature is summarized below in the *Efficiency* section. An additional stream of literature explores aggregate productivity growth of the audit industry over time. We summarize this research in the *Productivity* section.

The industrial organization literature shows that efficiencies occur through learning in production and service settings (Argote, 2012). We summarize the literature on learning in service settings and the limited evidence on learning in the audit setting in the *Learning* section.

Effort

The literature on audit effort investigates how audit effort is associated with engagement, client, and auditor characteristics and whether measures of audit effort are associated with measures of audit quality. Audit effort is typically measured as the number of audit hours expended for a particular engagement.

Davis, Ricchiute, and Trompeter (1993) examine whether the joint provision of non-audit and audit services creates production efficiencies using total audit hours, billing rate data, and total audit fee data from a large public accounting firm. They find no evidence of knowledge spillovers

from non-audit to audit services. Further, they find that the higher audit fees charged for clients that also demand non-audit services fees can be attributed to increased audit effort.

O'Keefe, Simunic, and Stein (1994) explore the production of audit services by first establishing a conceptual framework to study the auditor's production problem and then empirically testing the predicted relationships. They specify audit effort as the input to the production model and the level of assurance achieved as the output. Because the level of assurance is unobservable, they use labor hours per rank to proxy for effort and assume that client characteristics affect these inputs, assuming a constant level of assurance. The audit firm's objective is to minimize labor hours at every level. Empirically, they examine how client characteristics, client risk, client internal controls, audit firm tenure, and knowledge spillovers from other services provided are associated cross-sectionally with labor hours disaggregated by rank. Using engagement data from a major public accounting firm in 1989, they find that a large proportion of variation in total audit effort is explained by client size, complexity, and risk. They find internal control reliance, tenure of the audit firm, and the provision of non-audit services are not associated with audit hours.

Stein, Simunic, and O'Keefe (1994) explore differences in the association of client characteristics with disaggregated audit labor hours across industries, assuming audit firms produce a constant level of assurance. Using data on financial services and industrial clients from a major public accounting firm in 1989, they find that a measure of cash flow risk predicts total effort and that disaggregated labor hours varies across industries. Nevertheless, client size and complexity explain the largest proportion of variation in audit hours for both industries.

Davidson and Gist (1996) examine the association between the extent of audit planning and total audit effort. The authors conjecture that an increase in audit planning results in enhanced efficiency, thereby decreasing total audit hours. Using a sample of engagements from the Big 6 accounting firms for 1988--1990, they find some evidence that audit planning hours reduce total audit hours.

Hackenbrack and Knechel (1997) examine the relationship between engagement characteristics (client size, client industry, client complexity, nature of ownership, internal control reliance, and the provision of consulting services) and labor hours disaggregated by rank and audit activity. Using data collected from a survey on engagements from a major public accounting firm in 1991, the authors find that audit activity assignments vary across rank and that differences in engagement characteristics explain labor mix differences across audit activities.

Blokdijk, Direenhuizen, Simunic, and Stein (2006) examine how audit effort (i.e., hours) and the allocation of audit effort to different audit phases (planning, risk assessment, substantive testing, and audit completion) differ across Big 5 and non-Big 5 audit firms, which are assumed to provide a different levels of audit quality. Using a sample of 113 audits of 14 Dutch audit firms in 1998 and 1999, the authors finds that Big 5 and non-Big 5 audit firms exert a similar amounts of total audit effort, but Big 5 audit firms exert more effort for planning and risk assessment and less for substantive testing and completion. Further, Big 5 and non-Big 5 firms differ in the relations between audit hours and client size, business risk auditing, and the reliance on the client's internal controls.

Bell, Doogar, and Solomon (2008) investigate the effect of adopting business risk auditing (BRA), which changes total audit hours and the labor allocation across ranks. Further, the authors examine whether BRA has an effect on the relative allocation of hours across different audit engagements. For a sample of 165 audits of a Big 4 firm during 2002—2003, average total audit hours are 10% lower after adopting BRA when compared to estimated levels of audit hours before BRA adoption. Further, the share of partner and manager hours increases by 40% after BRA adoption. Further, engagements with higher assessed audit business risk are assigned more partner and manager hours and more total audit hours. When controlling for other factors that predict audit hours, audit business risk assessment is associated higher labor hours at every rank.

Schelleman and Knechel (2010) examine whether and how financial reporting risk (i.e., the level of short-term accruals in the financial statements) is associated with engagement labor mix, pricing, and profit margins. For a sample of Dutch audits of an international accounting firm in 1997, the authors find that professional staff engagement hours are higher when accruals are higher, and that audit firms use more supervisor, assistant, and support time for audits with higher accruals. Further, audit fees due to higher audit hours, and client accruals are not associated with profit margins.

Bae, Choi, and Rho (2016) investigate whether auditor industry specialists, which have been shown to charge a specialist premium, do so because they expend more effort. Using data from Korea, the authors find while auditor industry specialists charge higher fees than non-specialists, they also report more audit hours.

Audit efficiency

This stream of literature investigates relative (in)efficiency of engagements by comparing billing realization rates of different engagements or using data envelopment analysis (DEA) to estimate efficient production frontiers and then comparing engagements to the efficient frontier.

Dopuch, Gupta, Simunic, and Stein (2003) investigate relative efficiency of U.S. audit engagements of a Big 6 accounting firm from 1989 by employing stochastic frontier estimation (SFE) and DEA. The authors find no difference in efficiency across audits using SFE, but identify inefficiencies across audit engagements employing DEA with an average efficiency level of 88%. These inefficiencies are not all passed on to the client--- the average billing rate decreases as inefficiencies increase.

Knechel, Rouse, and Schelleman (2009) adopt the conceptual framework of O'Keefe, Simunic, and Stein (1994) and build on Hackenbrack and Knechel (1997) to develop a model of audit production based on DEA. The authors consider the labor costs and disaggregated labor hours for evidence-gathering activities as inputs, assuming that more critical evidence-gathering activities lead to a higher level of assurance. They assume that client characteristics are exogenous factors that affect audit production. They also relax the assumption that the level of assurance is constant across all audits by a certain firm. Using data on U.S. audit engagements

from a large international accounting firm, the study finds that efficiency varies across industries and offices and that efficiencies are higher for large clients with December year-end, but are lower complex clients, engagements that rely on the client's internal controls, and when tax services are provided. The study also finds that typical archival measures of audit effort (e.g., audit fees and audit report lag) are not correlated with DEA-based efficiency measures.

Chang, Kao, Mashruwala, and Sorenson (2018) use DEA to examine whether billing realization rates are associated with staff allocation and technical inefficiencies. Using a sample of Big 4 engagements, the authors find cross-sectional differences in inefficiencies across audit engagements and that both types of inefficiencies are negatively associated with billing realization rates.

Dekeyser, Gaeremynck, and Willekens (forthcoming) examine whether total and disaggregated labor hours are lower for clients in industries in which the audit firm serves more clients. Further, the authors investigate the extent to which efficiency gains are passed on from audit firm to the client depends on the auditor's market power. Using engagement data for all private firms of a Belgian Big 4 audit firm in 2000, the authors find evidence of efficiency gains from industry scale that do not come at the expense of audit quality. They further find that auditors with more market power have higher billing rates compared to auditors with less market power.

Productivity

Another stream of literature investigates aggregate productivity changes of the audit industry over time, including whether there are changes in the factors of production.

Banker, Chang, and Cunningham (2003) estimate an industry production function for the public accounting industry to assess whether there are scale economies and estimate marginal revenue products of various types of service employees. Using data for 64 large CPA firms over the period 1995--1998, they find overall productivity improvements and increasing returns to scale in the public accounting industry, which could explain M&A activity among audit firms.

Banker, Chang, and Natarajan (2005) analyze the effects of changes in technology and the rise of management advisory services on productivity, technical progress, and the relative efficiency of 64 large audit firms in the U.S. for the period 1995--1998. Using DEA, they find productivity growth occurred during this period that was partly offset by declining relative efficiency change. They attribute the productivity growth to technical progress and investment in management advisory services.

Chang, Choy, Cooper, Parker, and Ruefli (2009) examine productivity growth, technical progress, and efficiency change in the audit industry by comparing periods pre- and post-Sarbanes-Oxley periods. Using DEA analysis, they find productivity growth of 17% across the two periods which they attribute to technical progress. Further, they find that non-Big 4 firms have larger productivity growth and technical progress compared to Big 4 firms.

Chang, Chen, Duh, and Li (2011) use data on the operations of large accounting firms in Taiwan over 1993--2003 to decompose productivity growth into efficiency change, technical progress, information technology capital accumulation, and human capital accumulation. They find that productivity growth and the difference in productivity growth between Big 4 and non-Big 4 accounting firms are primarily attributable to the accumulation of IT and human capital. Further, they find that human capital and IT capital accumulation is associated with growth in non-audit services.

Learning

The industrial organization literature has investigated whether production is influenced by learning by doing and organizational learning. Productivity gains from learning (i.e., learning curves) have been estimated in many production settings (Argote, 2012), but have received little attention in service settings in general, and in the audit setting in particular.

Darr, Argote, and Epple (1995) examine learning by doing, the depreciation of knowledge, and the transfer of knowledge in pizza production. The study provides evidence that unit production costs decrease with learning but that knowledge from learning by doing depreciates quickly in this setting. The transfer of knowledge takes place within a network, but not across networks.

Pisano, Bohmer, and Edmondson (2001) investigate whether learning the same task in service organizations varies across organizations. Examining learning rates of applying the same technology in cardiac surgery across different departments, the authors find differences in learning rates across organizations and that cumulative experience predicts learning.

Reagans, Argote, and Brooks (2005) examine whether and how three factors affect learning in a service setting: the proficiency of individuals, the ability to leverage knowledge of others in the organizations, and the firm's capacity to coordinate activity inside the organization. The study finds that all three factors significantly predict learning rates in the organization.

Boone, Ganeshan, and Hicks (2008) investigate learning and depreciation of knowledge in an architectural engineering firm. Based on a dataset that extends over multiple years, the authors find estimate a learning that has no depreciation of knowledge and a higher rate of learning over time.

Beck and Wu (2006) examine the joint effect of auditors' learning on the job and learning from the provision of non-audit services on audit efficiency and audit quality. The authors suggest that such learning reduces audit costs, thereby increasing audit efficiency and enhancing audit quality. The authors develop an analytic model in which on the job learning decreases but learning from non-audit services persists over time in an unstable environment, which can either increase or decrease the audit firm's engagement risk, depending on the fees charged.

Causholli (2016) investigates the association between audit firm tenure and labor resources used to produce an audit. If organizational learning exists in the audit setting, then more client-specific

production experience should result in fewer audit hours by the audit team to complete the engagement. However, learning rates differ could across different labor inputs (personnel ranks), and learning might not be linear over time, as was assumed by prior literature (O'Keefe, Simunic, and Stein 1994; Blokdijk, Direenhuizen, Simunic, and Stein 2006) or can depreciate (e.g., Darr, Argote, and Epple 1995). Using proprietary data from annual audits completed before the implementation of Sarbanes-Oxley, the author finds that labor costs decrease with client-specific experience, but that this varies across ranks, with only higher-level ranks learning from experience. Further, the study finds evidence of knowledge depreciation for partners that results in increased production costs after the learning period.

He, Kothari, Xiao, and Zuo (2018) explore the audit quality consequences of knowledge transfers in audit firms by examining mergers of audit firms that had different levels of industry expertise prior to the merger. In the Chinese setting, the study finds that audit quality improves for clients audited by non-industry specialists who subsequently merged with industry specialists.

References

Argote, L. (2012). *Organizational learning: Creating, retaining and transferring knowledge*. Springer Science & Business Media.

Bae, G. S., Choi, S. U., and J. H. Rho (2016). Audit hours and unit audit price of industry specialist auditors: Evidence from Korea. Contemporary Accounting Research 33 (1), 314--340.

Banker, R. D., Chang, H., and R. Cunningham (2003). The public accounting industry production function. Journal of Accounting and Economics 35 (2), 255--281.

Banker, R. D., Chang, H., and R. Natarajan (2005). Productivity change, technical progress and relative efficiency change in the public accounting industry. Management Science 51 (2), 291--304.

Beck, P. J. and M. G. H. Wu (2010). Learning by doing and audit quality. Contemporary Accounting Research 31 (1), 1--30.

Bell, T. B., Doogar, R., and I. Solomon (2008). Audit labor usage and fees under business risk auditing. Journal of Accounting Research 46 (4), 729--760.

Blokdijk, H., Direenhuizen, F., Simunic, D. A., and M. T. Stein (2006). Analysis of Cross-Sectional Differences in Big and Non-Big Public Accounting Firms' Audit Programs. Auditing: A Journal of Practice & Theory 25 (1), 27--48.

Boone, T., Ganeshan, R., and R. L. Hicks (2008). Learning and knowledge depreciation in professional services. Management Science 54 (7), 1231--1236.

Causholli, M. (2016). Evidence of organizational learning and organizational forgetting from financial statement audits. Auditing: A Journal of Practice & Theory 35 (2), 53--72.

Chang, H., Chen, J., Duh, R., and S. Li (2011). Productivity growth in the public accounting industry: The roles of information technology and human capital. Auditing: A Journal of Practice & Theory 30 (1), 21--48.

Chang, H., Choy, H. L., Cooper, W. W., Parker, B. R., and T. W. Ruefli (2009). Measuring productivity growth, technical progress and efficiency changes of CPA firms prior to, and following the Sarbanes-Oxley Act. Socio-Economic Planning Sciences 43 (4), 221--228.

Chang, H., Kao, Y-C., Mashruwala, R., and S. M. Sorenson (2018). Technical inefficiency, allocative inefficiency, and audit pricing. Journal of Accounting, Auditing & Finance 33 (4), 580--600.

Darr, E. D., Argote, L., and D. Epple (1995). The acquisition, transfer, and depreciation of knowledge in service organizations: Productivity in franchises. Management Science 41 (11), 1750--1762.

Davidson, R. A. and W. E. Gist (1996). Empirical evidence on the functional relation between audit planning and total audit effort. Journal of Accounting Research 34 (1), 111--124.

Davis, L. R., Ricchiute, D. N., and G. Trompeter (1993). Audit effort, audit fees and the provision of nonaudit services to audit clients. The Accounting Review 68 (1), 135--150.

Dekeyser, S., Gaeremynck, A. and M. Willekens (forthcoming). Evidence of industry scale effects on audit hours, billing rates, and pricing. Contemporary Accounting Research.

Dopuch, N., Gupta, M., Simunic, D.A., and M.T. Stein (2003). Production Efficiency and the Pricing of Audit Services. Contemporary Accounting Research 20 (1), 47--77.

Hackenbrack, K. E. and W. R. Knechel (1997). Resource allocation decisions in audit engagements. Contemporary Accounting Research 14 (3), 481--499.

He, X., Kothari, S.P., Xiao, T., and L. Zuo (2018). Knowledge Transfer in Audit Firms. Working paper, accessible at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3209590

Knechel, W. R., Rouse, P., and C. Schelleman (2009). A modified audit production framework: evaluating the relative efficiency of audit engagements. The Accounting Review 84 (5), 1607--1638.

O'Keefe, T. B., Simunic, D. A., and M. T. Stein (1994). The production of Audit Services: Evidence form a Major Public Accounting Firm. Journal of Accounting Research 32 (2), 241--261.

Pisano, G.., Bohmer, R. M. J., and A.C. Edmondson (2001). Organizational differences in rates of learning: Evidence from the adoption of minimally invasive cardiac surgery. Management Science 47 (6), 752--768.

Reagans, R., Argote, L., and D. Brooks (2005). Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together. Management Science 51 (6), 869--881.

Schelleman, C. and W.R. Knechel (2010). Short-term accruals and the pricing and production of audit services. Auditing: A Journal of Practice & Theory 29 (1), 221--250.

Stein, M. T., Simunic, D. A., and T. B. O'Keefe. (1994). Industry differences in the production of audit services. Auditing: A Journal of Practice and Theory 13 (11), 128--142.