Piercing Complex Corporate Veils: Theory and Evidence*

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August 2022

Abstract

Under the doctrine of piercing the corporate veil, a court may invalidate limited liability protection and hold shareholders, such as parent companies, liable for the debt of a subsidiary within a corporate group. This paper develops a game-theoretic model of corporate veil-piercing. A court chooses a piercing rate to specify how often the court pierces a corporate veil. A corporate group chooses the length of an ownership chain to specify how many veils the group builds into the chain. The Nash equilibrium is characterized with bargaining weight, agency cost, and net liability. The comparative statics of the equilibrium with respect to the bargaining weight predict a hump-shaped relationship between piercing rate and ownership length. This paper also provides empirical evidence to support the hump-shaped relationship by using data on veil piercing, internal ownership, state incorporation, and financial accounting. When courts raise piercing rates from 0.26, as in Maryland, to 0.50, as in New York, corporate groups appear to increase the mean length of ownership chains by 0.52. When courts raise piercing rates from 0.50 to 0.68, as in Tennessee, corporate groups decrease the mean length by 0.45.

JEL classification: D23, K22, L22

Keywords: corporate group, limited liability, piercing rate, ownership length, hump-shaped relationship

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*I would like to thank Peter B. Oh, Jae Hyun Gwon, Masaki Iwasaki, and Dhammika Dharmapala for insightful comments. An earlier version of this paper was presented at the KLEA monthly seminar. I am grateful to the participants for comments. This research was supported by the National Research Foundation of Korea funded by the Korean Government (2022S1A5A8051446).

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1 Introduction

In principle, a company's shareholders, individual or corporate, are protected by limited liability, which ensures that the shareholders are responsible for the company's debt only up to the capital they invested in the company.[1] However, under the doctrine of piercing the corporate veil, a court can decide to invalidate limited liability protection and to hold the shareholders liable for the company's debt without any limit.[2]

In a modern economy, where value creation is divided among multiple sectors and regions, a company often takes the form of a corporate group, which consists of a parent company and its subsidiaries. The parent company is a corporate shareholder of its subsidiaries. Even if they are separate legal entities, the parent company may be held liable for its subsidiaries' debt by a court under the veil-piercing doctrine. Expecting the court's decision, the corporate group, or the parent company, can choose to organize a more complex structure to own and operate its subsidiaries to reduce the likelihood of liability. In turn, the court can choose to pierce complex corporate veils between the parent and subsidiary companies more easily and frequently. Therefore, the internal ownership structures of corporate groups are influenced by the veil-piercing decisions of courts, or vice versa.

In this paper I develop a game-theoretic model of corporate veil-piercing between a court and a corporate group. The court chooses a piercing rate to specify how often the court pierces a corporate veil. The group chooses the length of an ownership chain to specify how many veils the group builds into the chain. While the court's best response function is increasing in ownership

[1] Section 6.22(b) of the Model Business Corporation Act stipulates that a corporation's shareholders are not personally liable for the acts or debts of the corporation unless the shareholders may become personally liable by reason of their own acts or conduct. Section 102(b)(6) of the Delaware General Corporation Law also provides for limited liability.

[2] For example, see *In re Silicone Gel Breast Implants Products Liability Litigation*, 887 F.Supp. 1447 (1995). Bristol-Myers Squibb Company (Bristol) was the sole shareholder of Medical Engineering Corporation (MEC), which supplied breast implants. Bristol had never itself produced or distributed breast implants. Plaintiffs, injured from using MEC's breast implants, sued Bristol for damages. The court emphasized the fact-intensive nature of corporate veil-piercing and denied Bristol's motion for summary judgment.

length, the group's best response function is hump-shaped in piercing rate. I characterize the Nash equilibrium with the parameters of the model, such as bargaining weight, agency cost, and net liability. The comparative statics of the equilibrium with respect to the bargaining weight predict a hump-shaped relationship between piercing rate and ownership length.[3]

In addition I examine the empirical relationship between piercing rate and ownership length.[4] I combine veil-piercing data from Oh (2010) with data on internal ownership, state incorporation, and financial accounting, respectively from the Orbis database of Bureau van Dijk, the EDGAR system of the U.S. Securities and Exchange Commission, and the Eikon database of Thomson Reuters. By using quadratic regressions, I find a significant hump-shaped relationship between piercing rate and ownership length. This finding is consistent with the theoretical prediction, which is based on the comparative statics of the equilibrium. The peak of mean length is estimated to be 2.32 and reached at a piercing rate around 0.48. If courts raise piercing rates from 0.26, which equals the piercing rate in Maryland, to 0.50, which equals the piercing rate in New York, corporate groups appear to increase the mean length of ownership chains by about 0.52. If courts raise piercing rates from 0.50 to 0.68, which equals the piercing rate in Tennessee, corporate groups decrease the mean length of ownership chains by 0.45. If courts reduce piercing rates from 0.50 to 0.34, which equals the piercing rate in Delaware, corporate groups decrease the mean length of ownership chains by 0.19.

Veil piercing has been a central topic in corporate law. Most of legal studies focus on the conceptual analysis of veil piercing.[5] Thompson (1991) first conducts an empirical investigation and finds variations in piercing rates

[3]The bargaining weight may change due to changes in laws regarding the doctrine of piercing the corporate veil. Stricter laws for piercing imply that the court is given a lower bargaining weight for plaintiff-creditors.

[4]In the empirical analysis, ownership length is averaged over all ownership chains for each corporate group, and called mean length, because explanatory variables are defined at the group level.

[5]Blumberg (1986, 2005) study the concepts of limited liability and veil piercing within corporate groups. Easterbrook and Fischel (1985) discuss the economic rationale for limited liability and the circumstances in which courts may waive limited liability. Hansmann and Kraakman (1991) argue for unlimited shareholder liability in tort cases.

depending on the characteristics of courts, plaintiffs, or causes of action. Matheson (2009) studies 360 veil-piercing cases involving parent and subsidiary companies. Most broadly, Oh (2010) collects 2,908 cases in the United States and confirms variations in piercing rates across states.

Internal ownership structures of corporate groups have attracted increasing attention from researchers in economics.[6] Almeida and Wolfenzon (2006) develop a model of pyramidal ownership to show that corporate groups may organize pyramidal structures to exploit payoff and financing advantages for controlling shareholders.[7] Hong (2022) finds that multinational corporate groups reduce effective tax rates by using indirect ownership chains with foreign equity holding companies in countries with favorable tax treaties.[8]

Incorporation choices of firms under various state laws have been studied in law and economics. Bebchuk and Cohen (2003) study the effects of anti-takeover laws on incorporation choices. Dammann and Schündeln (2011) use veil-piercing data from Thompson (1991) and examine the relationship between veil-piercing risks and out-of-state incorporations.[9]

To my knowledge, there have been no studies on how veil-piercing decisions influence corporate ownership structures, with the only exception, Belenzon et al. (2018). In their theoretical model, a corporate group chooses

[6]The theory of the firm deals with the issues on the organization and operation of business entities. Previous studies tend to focus on the relationship between shareholders and managers. Jensen and Meckling (1976) analyze the agency problem due to the conflict of interests between shareholders (owners) and managers. Aghion et al. (2013) examine the role of institutional shareholders on innovation.

[7]Riyanto and Toolsema (2008) suggest that corporate groups may choose pyramidal structures to boost tunneling (upward cash flows) and propping (downward cash flows). Almeida et al. (2011) find that Korean groups (chaebols) choose pyramidal ownership when they acquire companies with low pledgeable income and high acquisition premiums. Bena and Ortiz-Molina (2013) examine the financing advantage of pyramidal structures.

[8]Dyreng et al. (2015) also discover that corporate groups use foreign holding companies to obtain treaty benefits, such as reduced withholding taxes on dividends. Lewellen and Robinson (2013) find that tax considerations are important factors in organizing foreign ownership chains of American groups. Mintz and Weichenrieder (2010) find that German groups set up indirect ownership chains to foreign subsidiaries for tax motives.

[9]Dammann and Schündeln (2012) investigate the formation choices of limited liability companies. Moon (2020) examines the legal grounds of offshore incorporations and discusses their implications for corporate law.

not to incorporate a new subsidiary when piercing probability is high enough. Empirical results also show a significant and negative relationship between country-level piercing score and subsidiary number. However, in Belenzon et al. (2018), the corporate group can choose only a horizontal structure but not a vertical (pyramidal) structure. The court is not a decision-maker and piercing probability is assumed to be given.

The rest of this paper is organized as follows. Section 2 develops a game-theoretic model of corporate veil-piercing. Section 3 analyzes equilibrium behavior. Section 4 examines the empirical relationship between veil piercing and ownership structures. Section 5 concludes.

2 Model

A corporate group, or simply a group, consists of a parent company and its subsidiaries.[10] Within the group, an ownership chain is a series of legal entities with direct ownership relations from the parent company to a terminal subsidiary. Each ownership chain describes how the parent company owns a terminal subsidiary. The length of an ownership chain, denoted by l, is defined as the number of distinct direct ownership relations in the chain.

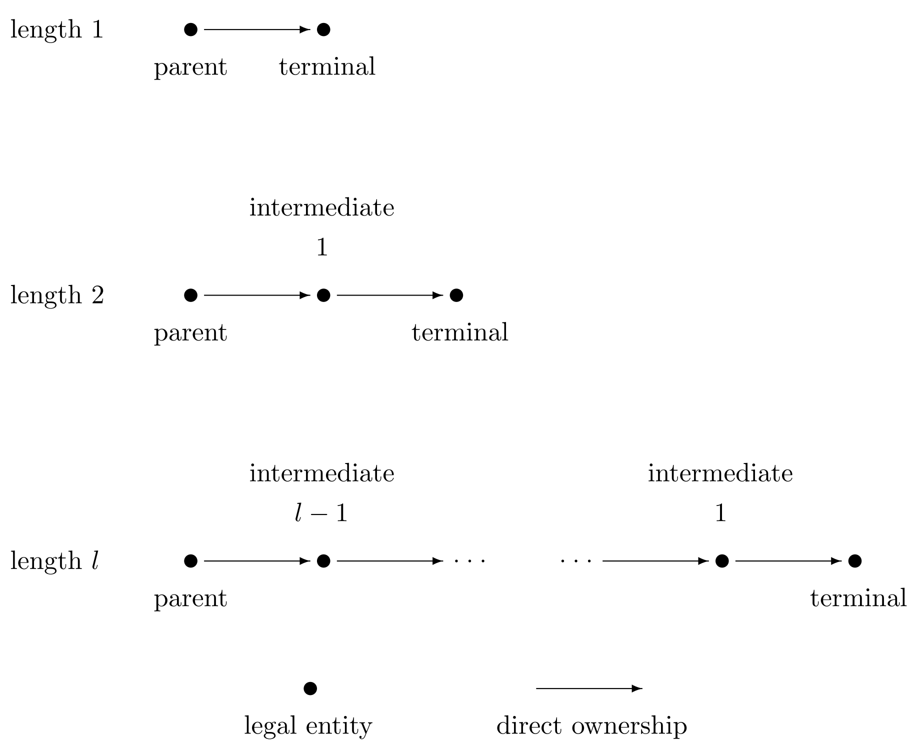
The parent company may own a terminal subsidiary directly or indirectly through intermediate subsidiaries. If $l = 1$, the parent company directly owns a terminal subsidiary. If $l = 2$, the parent company owns an intermediate subsidiary, which owns a terminal subsidiary. Generally, if $l \geq 2$, the parent company indirectly owns a terminal subsidiary through a series of $l - 1$ intermediate subsidiaries. Figure 1 illustrates examples of ownership chains.

The group plans to invest capital $k > 0$ to own and operate a terminal subsidiary, which will generate income m. Before it is realized, income m is a random variable. It may be realized as a profit $m \geq 0$ or a loss $m < 0$.

If the terminal subsidiary incurs a loss that exceeds the capital, i.e., if

[10] Within the group, a legal entity is called a subsidiary if it is owned directly or indirectly by the parent company. A subsidiary is called terminal if it owns no other subsidiaries. A subsidiary is called intermediate if it is not terminal, i.e., if it owns another subsidiary.

Figure 1. Ownership chains



$m+k<0$, a court decides whether to pierce a corporate veil. The likelihood of the veil-piercing decision, denoted by p, is referred to as the piercing rate.[11]

The group, or the parent company, is liable for the terminal subsidiary's loss $m+k$ with probability p^l, where l is the length of the ownership chain from the parent company to the terminal subsidiary.[12] The group is protected by limited liability, and thus not liable for the loss, with probability $1-p^l$.

[11] When dealing with an actual case, a court considers relevant facts, including transaction and ownership structures, and then makes the veil-piercing decision in the case. For brevity of analysis, I have not included such litigation stages, possibly involving strategic plaintiff-creditors, in my model. The court acts as a moderator by assigning a bargaining weight for creditors, and chooses the likelihood of the veil-piercing decision.

[12] One may think of length l as the number of corporate veils, piercing rate p as the probability of piercing one veil at a time, and p^l as the probability of piercing all l veils. Thus, with probability p^l, the court allows the terminal subsidiary's creditors to reach the parent company's assets.

To balance these outcomes the court considers a bargaining weight b with $0 < b < 1$. The court chooses the piercing rate p to maximize the following payoff function:

$$(1 - p^l)^{1-b}(p^l)^b$$

When organizing an ownership chain with length l, the group incurs an agency cost cl, where $c > 0$ is the marginal cost. Given a net liability $n < 0$, the group chooses l, the length of the ownership chain, to maximize the following payoff function:

$$np^l - cl$$

These payoff functions are actually derived from more general settings, as Remarks 1 and 2 show. I introduce some mathematical notations for the purpose of demonstrating them. Let $\mathrm{E}_m[\cdot]$ denote the expectation over m. Let $\Pr(m+k < 0)$ denote the probability that the terminal subsidiary incurs a loss exceeding the capital. Let $\Pr(m + k \geq 0)$ denote the probability of no such loss. Let $n = \Pr(m + k < 0)\mathrm{E}_m [(m + k) \mid m + k < 0]$ denote the net liability. Note that $n < 0$.

Remark 1. The court's payoff function can be derived from a bargaining model where creditors (plaintiffs) contend with the group (defendant) to recover the terminal subsidiary's debt $m + k$. As a moderator, the court considers the bargaining weight b for the creditors and $1 - b$ for the group. A bargaining solution of this model can be written as follows:

$$\mathrm{E}_m \left[(1 - p^l)^{1-b}(0 - (m + k))^{1-b}(p^l)^b(0 - (m + k))^b \mid m + k < 0\right]$$

Because p and l are independent of the random variable m, maximizing the court's payoff function is equivalent to maximizing the bargaining solution.

Remark 2. The group's payoff function can be derived from an expected payoff function of the following form:

$$\begin{aligned}\Pr(m + k \geq 0)&\mathrm{E}_m [m \mid m + k \geq 0] \\ &+ \Pr(m + k < 0)\mathrm{E}_m \left[0(1 - p^l) \mid m + k < 0\right] \\ &\qquad + \Pr(m + k < 0)\mathrm{E}_m \left[(m + k)p^l \mid m + k < 0\right] - cl\end{aligned}$$

Here the first term shows the expected profit or loss when $m + k \geq 0$ and it is independent of length l. The second term captures the limited liability protection when $m + k < 0$ and equals zero. The third term, showing the expected net liability when $m + k < 0$, can be simplified to np^l because p and l are independent of the random variable m. The last term is the agency cost. Therefore, maximizing the group's payoff function is equivalent to maximizing the expected payoff function.

3 Equilibrium Analysis

In this section I analyze strategic interactions between the court and the corporate group. The court's best response function assigns to each length l the best response $p(l)$, which maximizes the court's payoff function. The group's best response function assigns to each piercing rate p the best response $l(p)$, maximizing the group's payoff function. I characterize their best response functions.

Lemma 1. *Given length l, the court's best response function is $p(l) = b^{1/l}$.*

Proof. By differentiating the court's payoff function with respect to p, we obtain the first order condition:

$$(1-b)(1-p^l)^{-b}(-lp^{l-1})(p^l)^b + (1-p^l)^{1-b}b(p^l)^{b-1}l(p^{l-1}) = 0$$

By rearranging the terms, we obtain the following equation:

$$(1-p^l)(p^l)^{-1} = (1-b)b^{-1}$$

By solving for p, we obtain the court's best response function. In Appendix A, we see that the second order condition is satisfied. □

Let $\ln x$ denote the natural logarithm of x. Let e denote the base of the natural logarithm. Let $\exp(x) = e^x$ denote the exponential function of x.

Lemma 2. *Given piercing rate p, the group's best response function is $l(p) = (\ln c - \ln \ln p^n)/\ln p$.*

Proof. By differentiating the group's payoff function with respect to l, we obtain the first order condition:

$$n \cdot p^l \cdot \ln p - c = 0$$

By rearranging the terms, we obtain the following equation:

$$p^l = c / \ln p^n$$

By solving for l, we obtain the group's best response function. In Appendix A, we see that the second order condition is satisfied. □

Remark 3. (i) The court's best response function $p(l)$ is increasing in l. (ii) The group's best response function $l(p)$ is hump-shaped and peaks at $p = \exp(ce/n)$, i.e., it is increasing in p if $p < \exp(ce/n)$ and decreasing otherwise.

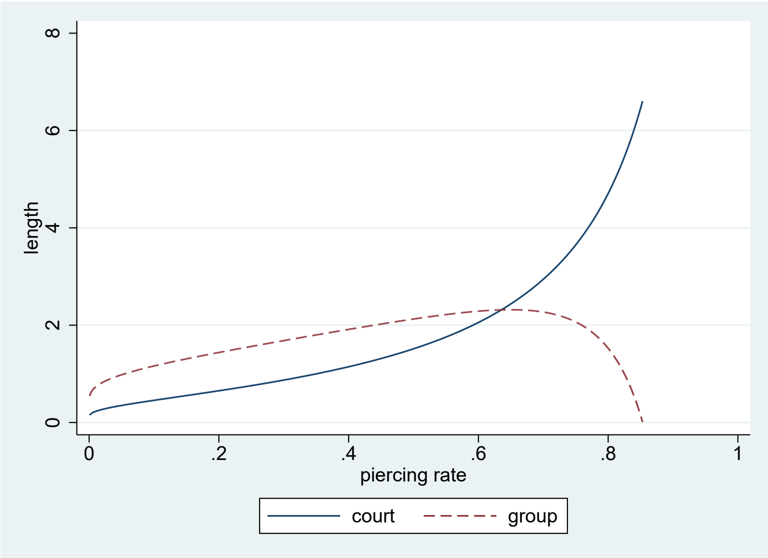
According to the court's best response function $p(l)$, the court decides to pierce corporate veils more frequently, as the group forms a longer ownership chain.

According to the group's best response function $l(p)$, the group chooses to organize a longer ownership chain, as the court pierces corporate veils more frequently but below the threshold $\exp(ce/n)$. However, if the court raises the piercing rate above the threshold, the group reduces the ownership length.

Figure 2 illustrates the graphs of the best response functions when $b = 0.35$, $c = 1.00$, and $n = -6.30$. The court's best response function, shown in the solid blue line, is increasing in length. The group's best response function, shown in the dashed red line, is hump-shaped and peaks at $p = 0.65$. These best response functions cross each other at $p^* = 0.64$ and $l^* = 2.31$.

Suppose that the court and the group move simultaneously. When choosing the piercing rate, the court does not know the length of the ownership chain. At the same time, when choosing the length of the ownership chain, the group does not know the piercing rate. In this simultaneous-move game,

Figure 2. Best response functions



the Nash equilibrium (p^*, l^*) arises when $p(l^*) = p^*$ and $l(p^*) = l^*$, i.e., when the best response functions cross each other. I characterize the Nash equilibrium.

Proposition 1. *In the Nash equilibrium* (p^*, l^*) *of the simultaneous-move game, the court chooses the piercing rate* $p^* = \exp(c/nb)$*, and the group chooses the ownership length* $l^* = (nb/c)\ln b$*.*

Proof. From Lemmas 1 and 2, we get the following equilibrium condition:

$$b = p^l = c/\ln p^n$$

Thus, it holds that $\ln p = c/nb$. By taking the exponential function on both sides, we obtain the equilibrium piercing rate p^* of the court. Because $b = p^l$, it holds that $\ln b = l \ln p$. By plugging p^* into this condition, we obtain the equilibrium ownership length l^* of the group. □

Figure 2 shows the Nash equilibrium $p^* = 0.64$ and $l^* = 2.31$ when $b = 0.35$, $c = 1.00$, and $n = -6.30$. In this numerical example, the court pierces a corporate veil with probability $p^* = 0.64$, and the group organizes an ownership chain with length $l^* = 2.31$.

The equilibrium may shift when the value of a parameter, such as bargaining weight b, agency cost c, or net liability n, changes. The comparative statics of the equilibrium lead to the following implications.

Remark 4. In equilibrium: (i) The piercing rate p^* is increasing in the bargaining weight b, decreasing in the agency cost c, and increasing in $|n|$, the absolute value of the net liability n. (ii) The ownership length l^* is increasing in b if $b < 1/e$ and decreasing otherwise. It is decreasing in c and increasing in $|n|$.

When the bargaining weight increases, the court pierces corporate veils more frequently. The group organizes a longer ownership chain until the bargaining weight reaches the threshold $1/e$, which is approximately 0.37. However, if the bargaining weight increases above the threshold, the group organizes a shorter ownership chain.

When the agency cost increases, the court pierces corporate veils less frequently and the group organizes a shorter ownership chain. When the net liability increases in absolute value, the court pierces corporate veils more frequently and the group organizes a longer ownership chain.

Let us imagine a situation where various courts are given different values for the bargaining weight. For instance, a state court is obliged to apply the laws of the state regarding the doctrine of piercing the corporate veil. Stricter state laws for piercing imply that the court is given a lower bargaining weight for the creditors who seek to pierce the veil. As Remark 4 implies, when the bargaining weight varies across courts, there is a hump-shaped relationship between piercing rate and ownership length in equilibrium. The following proposition characterizes the relationship.

Proposition 2. *As the bargaining weight b changes, in equilibrium, there is a hump-shaped relationship between piercing rate $p^*(b)$ and ownership length $l^*(b)$ such that $l^*(b) = \ln b / \ln p^*(b)$.*

Proof. From Proposition 1, in equilibrium (p^*, l^*), it holds $p^* = \exp(c/nb)$ and $l^* = (nb/c)\ln b$. For the comparative statics of the equilibrium with respect to the bargaining weight b, take the agency cost c and the net liability n as given. We can rewrite the equilibrium piercing rate as:

$$p^*(b) = \exp(c/nb)$$

By taking the natural logarithm function on both sides, we obtain $\ln p^*(b) = \ln \exp(c/nb) = c/nb$. By plugging this into the equilibrium ownership length, we find the following relationship:

$$l^*(b) = (nb/c)\ln b = \ln b / \ln p^*(b)$$

As Remark 4 shows, if $b < 1/e$, both $p^*(b)$ and $l^*(b)$ are increasing in b. However, if $b > 1/e$, $p^*(b)$ is increasing but $l^*(b)$ is decreasing in b. Thus, in equilibrium, there is a hump-shaped relationship between piercing rate $p^*(b)$ and ownership length $l^*(b)$ such that $l^*(b) = \ln b / \ln p^*(b)$. $\square$

In short, the comparative statics of the equilibrium with respect to the bargaining weight predict a hump-shaped relationship between piercing rate and ownership length.

4 Empirical Analysis

In this section I examine empirical evidence on the relationship between veil-piercing decisions and ownership structures. To this end I combine four sources of data.

First I use the Orbis database of Bureau van Dijk to obtain data on internal ownership structures of corporate groups.[13] I focus on a sample of corporations that are constituents of the S&P 500 index. This sample includes 488 corporations, each of which forms a corporate group. Table 1 presents summary statistics. For each corporate group, LENGTH denotes the mean length of ownership chains, and TOTAL denotes the total number

[13] Accessed in October 2017 at orbis.bvdinfo.com

of ownership chains. On average, a corporate group operates 1,305 terminal subsidiaries and organizes the same number of ownership chains with length of 2.27. In addition, for each corporate group, LENGTHD denotes the mean length of domestic ownership chains, and TOTALD denotes the total number of domestic ownership chains.[14] On average, a corporate group organizes 418 domestic ownership chains with length of 2.00.

Second I use the EDGAR system of the U.S. Securities and Exchange Commission (SEC) to obtain data on states of incorporation and principal executive offices.[15] I also obtain data on the standard industrial classification from the SEC's EDGAR system. INCDE is an indicator variable specifying whether the parent company of a corporate group is incorporated in Delaware (DE). PEOUT is an indicator variable specifying whether the parent company of a corporate group has principal executive offices outside the state of incorporation.[16] As Table 1 shows, 60% of corporate groups have parent companies incorporated in Delaware, and 72% have principal executive offices outside the state of incorporation. Industry dummies are defined with respect to the divisions of the standard industrial classification.

Third I obtain data on veil-piercing decisions from Oh (2010), who collects a set of 2,908 cases in the United States between the years 1658 and 2006 from the Westlaw database.[17] Table 6 of Oh (2010) provides state-level piercing rates. For each corporate group, PIERCINC denotes the piercing rate in the state of incorporation, and PIERCPEO denotes the piercing rate in the state of principal executive offices. In Table 1, on average, the piercing rate is 0.38 in the state of incorporation and 0.49 in the state of principal executive

[14] An ownership chain is called domestic if the parent company and the terminal subsidiary are incorporated in the same country.

[15] Accessed in December 2018 at www.sec.gov/edgar/searchedgar/companysearch.html

[16] Bebchuk and Cohen (2003) examine firms' choice of locations to incorporate and find a significant home-state advantage. However, about 59% of Fortune 500 firms are incorporated in Delaware (Table 2). Out-of-state incorporations among Fortune 500 firms take more than 70% of the total (Table 4).

[17] In this dataset there are 2,929 observations because cases involving different codefendants are divided into separate entries. The overall piercing rate is 0.4851 or 48.51%. Since the 1970s, the number of veil-piercing cases has increased sharply, but the piercing rate by decade has remained around the historical mean.

Table 1. Summary statistics

Variable	Description	Obs	Mean	SD	Min	Max
LENGTH	Mean length of ownership chains	488	2.27	1.20	1.00	8.51
LENGTHD	Mean length of domestic ownership chains	483	2.00	0.98	1.00	7.43
PIERCINC	Piercing rate in the state of incorporation	458	0.38	0.09	0.26	0.68
PIERCPEO	Piercing rate in the state of principal executive offices	460	0.49	0.08	0.26	0.68
INCDE	1 if incorporated in Delaware (DE)	488	0.60	0.49	0	1
PEOUT	1 if PEO is located outside the state of incorporation	488	0.72	0.45	0	1
NIBT	Net income before taxes in hundred billion USD	488	0.03	0.05	0.04	0.60
ASSET	Total assets in hundred billion USD	488	0.64	2.08	0.01	24.73
DAR	Ratio of total debt to total assets	488	0.30	0.18	0.00	1.10
TOTAL	Total number of ownership chains in hundreds	488	13.05	51.20	0.01	349.64
TOTALD	Total number of domestic ownership chains in hundreds	483	4.18	11.73	0.01	118.44

Table 2. Correlations

	LENGTH	LENGTHD	PIERCINC	PIERCPEO	TOTAL	TOTALD
LENGTH	-	0.89***	-0.02	0.01	0.73***	0.61***
LENGTHD	0.88***	-	-0.02	-0.002	0.71***	0.60***
PIERCINC	0.05	0.07	-	0.36***	-0.07	-0.09*
PIERCPEO	0.05	0.04	0.24***	-	-0.03	-0.03
TOTAL	0.43***	0.38***	-0.06	-0.01	-	0.88***
TOTALD	0.37***	0.42***	-0.03	-0.02	0.90***	-

Note: Pearson coefficients are presented above the diagonal and Spearman coefficients below. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

offices. The piercing rate is the lowest at 0.26 in Maryland and the highest at 0.68 in Tennessee, while it is 0.34 in Delaware and 0.50 in New York.

Fourth I use the Eikon database of Thomson Reuters to obtain financial accounting data of the corporate groups in the sample for the period 2013 to 2017.[18] For each corporate group, NIBT denotes net income before taxes, and ASSET denotes total assets, averaged for the five-year period and expressed in hundred billion US dollars. On average, a corporate group earns about 3 billion US dollars a year and owns about 64 billion US dollars. In addition, for each corporate group, DAR denotes the ratio of total debt to total assets, averaged for the five-year period. On average, a corporate group maintains its debt-to-asset ratio at 0.30.

Table 2 presents the Pearson and Spearman correlations. The mean length of ownership chains is positively correlated with the total number of ownership chains. However, the mean length of ownership chains is not significantly correlated with either of the piercing rates, while the correlation coefficients show opposite signs. In addition, the mean length of domestic ownership chains is positively correlated with the total number of domestic ownership chains. The mean length of domestic ownership chains is not significantly correlated with either of the piercing rates.

As Proposition 2 predicts, in equilibrium, there is a hump-shaped relationship between piercing rate and ownership length. To test this prediction, I set up regression models with quadratic terms for piercing rates.

$$\text{LENGTH}_{ijh} = \beta_0 + \beta_1 \text{PIERCINC}_h + \beta_2 \text{PIERCINC}_h^2 + \mathbf{G}_i' \boldsymbol{\gamma} + \delta_j + \varepsilon_{ijh}$$

Here LENGTH_{ijh} denotes the mean length of ownership chains for group i in industry j in state h. PIERCINC_h denotes the piercing rate in state h. $\mathbf{G}_i$ is a vector of group-specific variables, such as TOTAL, INCDE, PEOUT, and the interaction of the last two. $\mathbf{G}_i$ also includes the financial accounting variables. δ_j is the fixed effect of industry j. ε_{ijh} is the error term.

When LENGTHD is the dependent variable, TOTAL is replaced with TOTALD. PIERCINC can also be replaced with PIERCPEO.

[18] Accessed in September 2019 at eikon.thomsonreuters.com

A positive estimate for β_1 and a negative estimate for β_2 may be viewed as consistent with the hump-shaped relationship between piercing rate and ownership length.

Table 3 presents regression results with the piercing rate in the state of incorporation, PIERCINC. All regressions include industry dummies. Robust standard errors are reported in parentheses.

In column (1) of Table 3, PIERCINC is positively and significantly related to LENGTH, and PIERCINC^2 is negatively and significantly related to LENGTH. This result implies that the piercing rate in the state of incorporation shows a hump-shaped relationship with the mean length of ownership chains. According to the estimates in column (1), the mean length of ownership chains peaks at the piercing rate of 0.48. The peak of mean length is estimated to be 2.32 at the means of the other independent variables. If courts raise piercing rates but keep them below the threshold 0.48, corporate groups tend to organize longer ownership chains. However, if courts raise piercing rates above the threshold, corporate groups tend to organize shorter ownership chains.

For instance, if courts raise piercing rates from 0.26, which equals the piercing rate in Maryland courts, to 0.50, which equals the piercing rate in New York courts, corporate groups appear to increase the mean length of ownership chains by about 0.52, using additional corporate veils and incurring greater agency costs. A typical corporate group can increase the mean length of ownership chains by 0.52 by inserting an additional intermediate subsidiary into each of 679 ownership chains among its 1,305 chains.[19] If courts raise piercing rates from 0.50 to 0.68, which equals the piercing rate in Tennessee courts, corporate groups decrease the mean length of ownership chains by about 0.45. If courts reduce piercing rates from 0.50 to 0.34, which equals the piercing rate in Delaware courts, corporate groups decrease the mean length of ownership chains by about 0.19.

[19]This corporate group may set up one common intermediate subsidiary, or 679 distinct intermediate subsidiaries, along the 679 ownership chains. Thus, the agency cost of longer (more complex) ownership chains depends on the group's overall structure.

Table 3. Regression results with PIERCINC

	(1) LENGTH	(2) LENGTH	(3) LENGTHD	(4) LENGTHD
PIERCINC	10.38***	0.84	8.89**	0.86*
	(3.54)	(0.53)	(3.46)	(0.50)
$PIERCINC^2$	-10.87***		-9.15**	
	(3.87)		(3.72)	
INCDE	-0.64*	-0.57*	-0.39	-0.34
	(0.33)	(0.31)	(0.39)	(0.38)
PEOUT	0.06	-0.00	0.01	-0.04
	(0.13)	(0.14)	(0.11)	(0.12)
INCDE×PEOUT	0.66*	0.69**	0.46	0.49
	(0.35)	(0.34)	(0.41)	(0.40)
NIBT	1.33	1.46	0.26	0.37
	(1.33)	(1.34)	(1.21)	(1.21)
ASSET	0.04	0.04	0.06	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
DAR	0.14	0.12	0.14	0.12
	(0.28)	(0.29)	(0.31)	(0.31)
TOTAL	0.02***	0.02***		
	(0.001)	(0.001)		
TOTALD			0.04***	0.04***
			(0.01)	(0.01)
Constant	-0.58	1.43***	-0.46	1.19***
	(0.86)	(0.41)	(0.83)	(0.32)
Observations	458	458	456	456
R^2	0.61	0.60	0.46	0.45

Note: All regressions include industry dummies. Robust standard errors are shown in parentheses. ***, **, and * show significance at 1%, 5%, and 10%.

Table 4. Regression results with PIERCPEO

	(1) LENGTH	(2) LENGTH	(3) LENGTHD	(4) LENGTHD
PIERCPEO	6.50**	0.19	6.69**	0.02
	(2.83)	(0.41)	(2.75)	(0.42)
PIERCPEO^2	-6.74**		-7.11**	
	(3.00)		(2.89)	
INCDE	-0.61**	-0.64**	-0.39	-0.42
	(0.29)	(0.29)	(0.35)	(0.36)
PEOUT	-0.05	-0.04	-0.05	-0.04
	(0.14)	(0.13)	(0.14)	(0.14)
INCDE×PEOUT	0.62*	0.67**	0.39	0.44
	(0.33)	(0.33)	(0.39)	(0.40)
NIBT	1.40	1.43	0.30	0.36
	(1.33)	(1.33)	(1.19)	(1.20)
ASSET	0.04	0.04	0.06	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
DAR	0.09	0.07	0.07	0.04
	(0.28)	(0.29)	(0.31)	(0.31)
TOTAL	0.02***	0.02***		
	(0.001)	(0.001)		
TOTALD			0.04***	0.04***
			(0.01)	(0.01)
Constant	0.35	1.77***	0.03	1.54***
	(0.72)	(0.37)	(0.68)	(0.30)
Observations	460	460	458	458
R^2	0.61	0.61	0.46	0.45

Note: All regressions include industry dummies. Robust standard errors are shown in parentheses. ***, **, and * show significance at 1%, 5%, and 10%.

One may see an interesting relationship between corporate locations and ownership structures in column (1) of Table 3, though the coefficients are not highly significant. A corporate group appears to organize shorter ownership chains by 0.64 than the other groups do when its parent company is incorporated in Delaware and has principal executive offices in the state, i.e., when INCDE $= 1$ and PEOUT $= 0$. However, a corporate group tends to have slightly longer ownership chains by $0.08 = 0.66 + 0.06 - 0.64$ than the other groups do when its parent company is incorporated in Delaware and has principal executive offices outside the state, i.e., when INCDE $= 1$ and PEOUT $= 1$, though the coefficient for PEOUT is not significant.

In column (3) of Table 3, PIERCINC is positively and significantly related to LENGTHD, and PIERCINC^2 is negatively and significantly related to LENGTHD. The piercing rate in the state of incorporation shows a hump-shaped relationship with the mean length of domestic ownership chains.

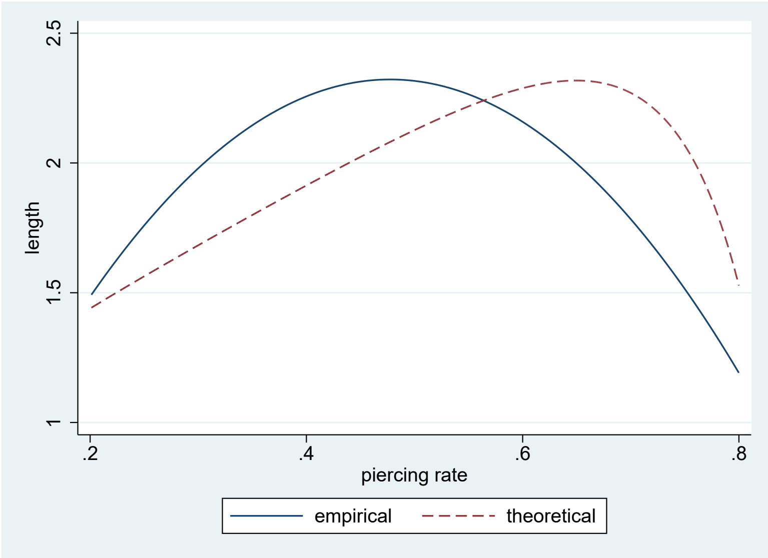
Columns (2) and (4), which do not include the quadratic term, show less significant results. PIERCINC is positively related to LENGTHD, but this relationship is significant only at the 10% level. PIERCINC is not significantly related to LENGTH.

Table 4 provides regression results with the piercing rate in the state of principal executive offices, PIERCPEO. All regressions include industry dummies. Robust standard errors are reported in parentheses.

In column (1) of Table 4, PIERCPEO is positively and significantly related to LENGTH, and PIERCPEO^2 is negatively and significantly related to LENGTH. Hence, the piercing rate in the state of principal executive offices shows a hump-shaped relationship with the mean length of ownership chains. According to the estimates in column (1), the mean length of ownership chains peaks at the piercing rate of 0.48. The peak of mean length is estimated to be 2.24 at the means of the other independent variables.

Specifically, if courts raise piercing rates from 0.26 (as in Maryland courts) to 0.50 (New York), corporate groups tend to increase the mean length of ownership chains by about 0.34. A typical corporate group can increase the

Figure 3. Empirical and theoretical predictions



mean length of ownership chains by 0.34 by adding an intermediate subsidiary into each of 443 ownership chains among its 1,305 chains. If courts raise piercing rates from 0.50 to 0.68 (Tennessee), corporate groups decrease the mean length of ownership chains by about 0.26. If courts reduce piercing rates from 0.50 to 0.34 (Delaware), corporate groups decrease the mean length of ownership chains by about 0.13.

In column (3) of Table 4, PIERCPEO is positively and significantly related to LENGTHD, and PIERCPEO^2 is negatively and significantly related to LENGTHD. Thus, the piercing rate in the state of principal executive offices shows a hump-shaped relationship with the mean length of domestic ownership chains. However, in columns (2) and (4) without the quadratic term, PIERCPEO is not significantly related to either LENGTH or LENGTHD.

Across Tables 3 and 4, the total number of ownership chains is positively and significantly related to the mean length of ownership chains. Likewise, the total number of domestic ownership chains is positively and significantly related to the mean length of domestic ownership chains. However, the financial accounting variables NIBT, ASSET and DAR are not significantly related to either of the ownership lengths.

Overall, I find a significant hump-shaped relationship between piercing rate and ownership length. This finding is consistent with the theoretical prediction in Proposition 2.

Figure 3 illustrates empirical and theoretical predictions within the range of the piercing rates in the data. The empirical prediction in the solid blue line is based on the estimates in column (1) of Table 3. The peak length of 2.32 is reached at a piercing rate around 0.48. The theoretical prediction in the dashed red line is based on the comparative statics of the equilibrium with respect to the bargaining weight b from Proposition 2, when $c = 1.00$ and $n = -6.30$. The peak length of 2.32 is reached at a piercing rate around 0.65. Both predictions show hump-shaped relationships between piercing rate and ownership length.

Because my empirical analysis is based on cross-sectional data, it is hard to conclude a causal effect of veil-piercing decisions on ownership structures. An unobserved factor can affect both piercing rate and ownership length. For instance, the bargaining weight may not be directly observable at the court level, or even at the state level, while influencing the two. To deal with this endogeneity issue, I use state-level corporate income tax rates and business friendliness measures as proxy variables for the bargaining weight, and present regression results in Appendix B.

Thus far, piercing rates are defined for cases in any courts within a state. Alternatively, piercing rates can be defined for cases in federal courts within a state. I provide regression results with such piercing rates in Appendix B.

5 Conclusion

In this paper I develop a game-theoretic model of corporate veil-piercing. A court chooses a piercing rate to specify how often the court pierces a corporate veil. A corporate group chooses the length of an ownership chain to specify how many veils the group builds into the chain.

While the court's best response function is increasing in ownership length, the group's best response function is hump-shaped in piercing rate. I characterize the Nash equilibrium with the parameters of the model, such as bargaining weight, agency cost, and net liability. The comparative statics of the equilibrium with respect to the bargaining weight predict a hump-shaped relationship between piercing rate and ownership length.

I also examine the empirical relationship between piercing rate and ownership length by combining data on veil piercing, internal ownership, state incorporation, and financial accounting. Empirical results, based on quadratic regression models, support a hump-shaped relationship between piercing rate and ownership length. This relationship is consistent with my theoretical prediction.

For future studies, it will be interesting to study the relationship between piercing rate and ownership length across countries. In this paper, I focused on variations in piercing rates across American states to explain the patterns of ownership structures. However, as the veil-piercing doctrine and its application differ across countries, there may exist variations in national piercing rates, which can influence internal ownership structures of corporate groups.

It will also be interesting to consider the role of a plaintiff-creditor as a strategic decision-maker. In my model, I assumed that a court would act as a moderator by assigning the bargaining weights for plaintiffs, who were not decision-makers. In more realistic circumstances, plaintiffs may choose their own litigation strategies against corporate groups, depending on the characteristics of lawsuits. Anticipating such litigation strategies, corporate groups can organize ownership structures to reduce liability.

Appendix A. Proofs

Proof of Lemma 1. Let $u(p,l) = (1-p^l)^{1-b}(p^l)^b$ denote the court's payoff function. By differentiating $u(p,l)$ with respect to p, and by rearranging the terms, we get:

$$\frac{\partial u}{\partial p} = -l(1-b)(1-p^l)^{-b}p^{lb+l-1} + lb(1-p^l)^{1-b}p^{lb-1}$$

By differentiating the first derivative with respect to p, and by rearranging the terms, we get:

$$\begin{aligned}\frac{\partial^2 u}{\partial p^2} &= lb(1-b)(1-p^l)^{-b-1}(-lp^{l-1})p^{lb+l-1} \\ &\quad - l(1-b)(1-p^l)^{-b}(lb+l-1)p^{lb+l-2} \\ &\quad + lb(1-b)(1-p^l)^{-b}(-lp^{l-1})p^{lb-1} \\ &\quad + lb(1-p^l)^{1-b}(lb-1)p^{lb-2} \\ &= (1-p^l)^{-b}p^{lb}p^{-2} \times [lb(1-b)(1-p^l)^{-1}(-lp^l)p^l \\ &\quad - l(1-b)(lb+l-1)p^l + lb(1-b)(-lp^l) + lb(1-p^l)(lb-1)]\end{aligned}$$

By evaluating the second derivative at $p = b^{1/l}$, and by rearranging the terms, we get:

$$\begin{aligned}\left.\frac{\partial^2 u}{\partial p^2}\right|_{p=b^{1/l}} &= (1-b)^{-b}b^b b^{-2/l} \times [lb(1-b)(1-b)^{-1}(-lb)b \\ &\quad - l(1-b)(lb+l-1)b + lb(1-b)(-lb) + lb(1-b)(lb-1)] \\ &= (1-b)^{-b}b^b b^{-2/l} \times lb \times [(-lb)b \\ &\quad - (1-b)(lb+l-1) + (1-b)(-lb) + (1-b)(lb-1)] \\ &= (1-b)^{-b}b^b b^{-2/l} \times lb \times [-l] < 0\end{aligned}$$

This is because $0 < b < 1$ and $l > 0$. Thus, the second order condition is satisfied. □

Proof of Lemma 2. Let $u(p,l) = np^l - cl$ denote the group's payoff function. By differentiating $u(p,l)$ with respect to l, we get:

$$\frac{\partial u}{\partial l} = n \cdot p^l \cdot \ln p - c$$

By differentiating the first derivative with respect to l, we get:

$$\frac{\partial^2 u}{\partial l^2} = n \cdot p^l \cdot (\ln p)^2 < 0$$

This is because $n < 0$. Thus, the second order condition is satisfied. □

Proof of Remark 3. (i) By differentiating $p(l) = b^{1/l}$ with respect to l, we get:

$$\frac{dp}{dl} = (b^{1/l})(\ln b)(-l^{-2})$$

Because $b < 1$, $\ln b < 0$ and $dp/dl > 0$. Thus, $p(l)$ is increasing in l.
(ii) By differentiating $l(p) = (\ln c - \ln \ln p^n)/\ln p$ with respect to p, we get:

$$\begin{aligned}\frac{dl}{dp} &= (-(\ln p^n)^{-1}(p^n)^{-1}np^{n-1})(\ln p)^{-1} + (\ln c - \ln \ln p^n)(-1)(\ln p)^{-2}p^{-1} \\ &= -(p^{-1})(\ln p)^{-2}(1 + \ln c - \ln \ln p^n)\end{aligned}$$

If $p < \exp(ce/n)$, then $1 + \ln c - \ln \ln p^n < 0$ and $dl/dp > 0$. If $p > \exp(ce/n)$, then $1 + \ln c - \ln \ln p^n > 0$ and $dl/dp < 0$. If $p = \exp(ce/n)$, then $dl/dp = 0$. Thus, $l(p)$ is increasing in p if $p < \exp(ce/n)$ and decreasing otherwise. □

Proof of Remark 4. (i) By differentiating $p^* = \exp(c/nb)$ with respect to each parameter, we get:

$$\begin{aligned}\frac{\partial p^*}{\partial b} &= \exp(c/nb)(-1)(c/nb^2) > 0 \\ \frac{\partial p^*}{\partial c} &= \exp(c/nb)(1/nb) < 0 \\ \frac{\partial p^*}{\partial n} &= \exp(c/nb)(-1)(c/n^2 b) < 0\end{aligned}$$

This is because $c > 0$, $n < 0$, and $0 < b < 1$. Thus, p^* is increasing in b, decreasing in c, and decreasing in n. Because $n < 0$ and $|n| = -n$, p^* is increasing in $|n|$.
(ii) By differentiating $l^* = (nb/c) \ln b$ with respect to b, we get:

$$\frac{\partial l^*}{\partial b} = (n/c)(1 + \ln b)$$

If $b < 1/e$, then $1 + \ln b = \ln eb < 0$ and $\partial l^*/\partial b > 0$. If $b > 1/e$, then $1 + \ln b > 0$ and $\partial l^*/\partial b < 0$. If $b = 1/e$, then $\partial l^*/\partial b = 0$. Thus, l^* is increasing in b if $b < 1/e$ and decreasing otherwise.

By differentiating l^* with respect to c and n, we get:

$$\frac{\partial l^*}{\partial c} = -(nb/c^2)\ln b < 0$$
$$\frac{\partial l^*}{\partial n} = (b/c)\ln b < 0$$

This is because $0 < b < 1$ and $\ln b < 0$. Thus, l^* is decreasing in c and decreasing in n. Because $|n| = -n$, l^* is increasing in $|n|$. □

Appendix B. Supplemental Analysis

Tables B.1 and B.2 show regression results with state-level corporate income tax rates (SCIT) and business friendliness measures (BUFR), which are presumed to be proxies for the bargaining weight. I obtain data on SCIT from the Tax Foundation and BUFR from CNBC for the year 2017.[20] For a state with more than one tax bracket, I take the tax rate for the highest bracket. CNBC's business friendliness, based on lawsuit and liability climates, regulatory regimes, and overall bureaucracy, is originally presented as a ranking for each state, with the most business friendly state ranked 1 and the least ranked 50. I convert the CNBC measure by taking 1-rank/50. Thus, the most business friendly state gets 0.98 and the least gets zero, while the converted measure is increasing in terms of business friendliness.

Columns (1) and (3) support hump-shaped relationships between piercing rate and ownership length, consistent with the theoretical prediction, after controlling for the proxies of the bargaining weight. Notably, PIERCINC is positively and significantly related to LENGTH, and PIERCINC^2 is negatively and significantly related to LENGTH. The two proxies, SCIT and BUFR, are not significantly related to LENGTH though BUFR appears to be significant for LENGTHD.

[20] Accessed at taxfoundation.org/state-corporate-income-tax-rates-brackets-2017 and at cnbc.com/americas-top-states-for-business-2017 in December 2018

In Table B.1, columns (2) and (4) also support linear relationships with statistical significance at the 10% level. However, in Table B.2, columns (2) and (4) report insignificant linear relationships.

Table B.3 shows regression results with PIERCINCF, which denotes the piercing rate in federal courts within the state of incorporation. In column (1), PIERCINCF is positively related to LENGTH, and PIERCINCF^2 is negatively related to LENGTH. In column (3), PIERCINCF is positively related to LENGTHD, and PIERCINCF^2 is negatively related to LENGTHD. Thus, the piercing rate in federal courts within the state of incorporation exhibits a hump-shaped relationship with the mean length of ownership chains, and with the mean length of domestic ownership chains. In columns (2) and (4) without the quadratic term, PIERCINCF is positively related to LENGTH and LENGTHD. Thus, the piercing rate in federal courts within the state of incorporation may also exhibit a linear relationship with ownership length.

Table B.4 shows regression results with PIERCPEOF, which denotes the piercing rate in federal courts within the state of principal executive offices. In contrast to the results in Tables 3, 4, and B.3, PIERCPEOF^2 is not significantly related to ownership length, while PIERCPEOF is positively and significantly related to ownership length. Thus, the piercing rate in federal courts within the state of principal executive offices shows a linear relationship with ownership length.

The piercing rate in federal courts within a state has not been published previously, and is provided by Peter B. Oh upon personal correspondence.

Table B.1. Regression results with PIERCINC, SCIT and BUFR

	(1) LENGTH	(2) LENGTH	(3) LENGTHD	(4) LENGTHD
PIERCINC	12.38***	0.88*	11.70***	0.83*
	(3.94)	(0.53)	(3.95)	(0.50)
$PIERCINC^2$	-13.04***		-12.32***	
	(4.27)		(4.29)	
INCDE	-0.73**	-0.61*	-0.50	-0.39
	(0.34)	(0.32)	(0.39)	(0.37)
PEOUT	0.05	-0.01	0.01	-0.05
	(0.13)	(0.14)	(0.11)	(0.12)
INCDE×PEOUT	0.66*	0.69**	0.45	0.48
	(0.35)	(0.34)	(0.41)	(0.40)
NIBT	1.38	1.49	0.42	0.52
	(1.33)	(1.34)	(1.19)	(1.19)
ASSET	0.04	0.04	0.06	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
DAR	0.13	0.11	0.09	0.07
	(0.28)	(0.29)	(0.31)	(0.32)
TOTAL	0.02***	0.02***		
	(0.001)	(0.001)		
TOTALD			0.04***	0.04***
			(0.01)	(0.01)
SCIT	2.03	0.84	0.98	-0.14
	(1.94)	(1.83)	(1.47)	(1.36)
BUFR	0.32	0.13	0.63***	0.45**
	(0.22)	(0.21)	(0.21)	(0.19)
Constant	-1.27	1.31***	-1.32	1.05***
	(1.02)	(0.44)	(0.98)	(0.35)
Observations	458	458	456	456
R^2	0.61	0.60	0.46	0.45

Note: All regressions include industry dummies. Robust standard errors are shown in parentheses. ***, **, and * show significance at 1%, 5%, and 10%.

Table B.2. Regression results with PIERCPEO, SCIT and BUFR

	(1) LENGTH	(2) LENGTH	(3) LENGTHD	(4) LENGTHD
PIERCPEO	6.90**	0.23	7.98***	0.01
	(2.93)	(0.42)	(2.80)	(0.41)
$PIERCPEO^2$	-7.12**		-8.50***	
	(3.10)		(2.96)	
INCDE	-0.65**	-0.67**	-0.44	-0.48
	(0.30)	(0.30)	(0.36)	(0.36)
PEOUT	-0.10	-0.08	-0.14	-0.12
	(0.14)	(0.14)	(0.13)	(0.12)
INCDE×PEOUT	0.66**	0.71**	0.46	0.53
	(0.33)	(0.33)	(0.39)	(0.39)
NIBT	1.47	1.49	0.51	0.54
	(1.33)	(1.34)	(1.16)	(1.18)
ASSET	0.04	0.04	0.06	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
DAR	0.09	0.08	0.06	0.04
	(0.28)	(0.29)	(0.31)	(0.31)
TOTAL	0.02***	0.02***		
	(0.001)	(0.001)		
TOTALD			0.04***	0.04***
			(0.01)	(0.01)
SCIT	0.31	0.31	-0.71	-0.71
	(1.91)	(1.86)	(1.47)	(1.41)
BUFR	0.21	0.13	0.54***	0.44**
	(0.21)	(0.21)	(0.19)	(0.19)
Constant	0.40	1.94***	-0.33	1.52***
	(0.77)	(0.34)	(0.72)	(0.30)
Observations	457	457	455	455
R^2	0.60	0.60	0.46	0.45

Note: All regressions include industry dummies. Robust standard errors are shown in parentheses. ***, **, and * show significance at 1%, 5%, and 10%.

Table B.3. Regression results with PIERCINCF

	(1) LENGTH	(2) LENGTH	(3) LENGTHD	(4) LENGTHD
PIERCINCF	2.41***	0.70**	2.09**	0.49**
	(0.93)	(0.30)	(0.84)	(0.24)
$PIERCINCF^2$	-1.78*		-1.67**	
	(0.91)		(0.81)	
INCDE	-0.55*	-0.55*	-0.36	-0.36
	(0.30)	(0.30)	(0.37)	(0.37)
PEOUT	-0.04	-0.03	-0.09	-0.08
	(0.13)	(0.13)	(0.12)	(0.12)
INCDE×PEOUT	0.70**	0.70**	0.52	0.52
	(0.34)	(0.34)	(0.40)	(0.40)
NIBT	1.52	1.52	0.41	0.41
	(1.36)	(1.33)	(1.22)	(1.21)
ASSET	0.04	0.04	0.06	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
DAR	0.06	0.07	0.06	0.08
	(0.28)	(0.28)	(0.31)	(0.31)
TOTAL	0.02***	0.02***		
	(0.001)	(0.001)		
TOTALD			0.04***	0.04***
			(0.01)	(0.01)
Constant	1.16***	1.53***	1.05***	1.39***
	(0.37)	(0.32)	(0.27)	(0.21)
Observations	458	458	456	456
R^2	0.60	0.60	0.45	0.45

Note: All regressions include industry dummies. Robust standard errors are shown in parentheses. ***, **, and * show significance at 1%, 5%, and 10%.

Table B.4. Regression results with PIERCPEOF

	(1) LENGTH	(2) LENGTH	(3) LENGTHD	(4) LENGTHD
PIERCPEOF	1.27*	0.41**	1.06*	0.42**
	(0.71)	(0.19)	(0.63)	(0.17)
$PIERCPEOF^2$	-0.84		-0.62	
	(0.67)		(0.57)	
INCDE	-0.57**	-0.58**	-0.33	-0.34
	(0.29)	(0.29)	(0.35)	(0.35)
PEOUT	-0.04	-0.03	-0.04	-0.03
	(0.13)	(0.13)	(0.13)	(0.13)
INCDE×PEOUT	0.59*	0.60*	0.34	0.35
	(0.33)	(0.33)	(0.39)	(0.39)
NIBT	1.45	1.47	0.36	0.37
	(1.34)	(1.33)	(1.19)	(1.19)
ASSET	0.04	0.04	0.06	0.06
	(0.03)	(0.03)	(0.04)	(0.04)
DAR	0.04	0.04	0.01	0.02
	(0.28)	(0.28)	(0.31)	(0.31)
TOTAL	0.02***	0.02***		
	(0.001)	(0.001)		
TOTALD			0.04***	0.04***
			(0.01)	(0.01)
Constant	1.49***	1.68***	1.23***	1.37***
	(0.36)	(0.32)	(0.27)	(0.22)
Observations	460	460	458	458
R^2	0.61	0.61	0.46	0.46

Note: All regressions include industry dummies. Robust standard errors are shown in parentheses. ***, **, and * show significance at 1%, 5%, and 10%.

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