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INTRACOMPANY GOVERNANCE AND INNOVATION

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ABSTRACT

This paper examines the relation between ownership, corporate form, and innovation for a cross-section of private and publicly traded innovating firms in the US and 15 European countries. A striking novel observation emerges from our analysis: while most innovating firms in the US are publicly traded conglomerates, a substantial fraction of innovation is concentrated in private firms and in business groups in continental European countries. We find virtually no variation across US industries in the corporate form of innovating firms, but a substantial variation across industries in continental European countries, where business groups tend to be concentrated in industries with a slower and more fundamental innovation cycle and where intellectual protection of innovators seems to be of paramount importance. Our findings suggest that innovative companies choose the corporate form most conducive to R&D, as predicted by the Coasian view of how firms form. This is especially true in Europe, where there are fewer regulatory hurdles to the formation of business groups and hybrid corporate forms. It is less the case in the US, where conglomerates are generally favored.

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1. Introduction

Which corporate forms are most propitious to innovation? Is it standalone firms financed by Venture Capital (VC)? Is it conglomerate incubators, or looser business-group and corporate alliance structures? While GE, Hewlett-Packard, IBM, DuPont or 3M are often mentioned as examples of highly innovative conglomerate firms in the U.S., there have also been many prominent examples of VC-backed standalones in recent years, such as Amazon, Netscape, or Google. Although VC-backed innovation has been less important in Europe, innovative activity in conglomerates such as Philips or Nokia is highly visible, and business-groups in the vein of Ericsson, Zeiss, Alstom and Novartis are also renowned innovators.

Economists and business scholars have pointed to the advantages of conglomerates in funding R&D projects with cheaper internally generated funds (Gertner, Scharfstein and Stein, 1994 and Stein, 1997) while at the same time emphasizing the *dark side* of internal capital markets, in terms of reduced financial discipline for poorly performing investments (Scharfstein and Stein, 2000). Seru (2007) finds evidence consistent with this dark side of internal capital markets: publicly traded U.S. conglomerates with above-average reallocation of funds across divisions are less productive innovators than comparable stand-alone firms. Similarly, Guedj and Scharfstein (2004) compare clinical trials in the biopharmaceutical industry and find that big pharmaceuticals firms engaged in cancer research tend to initiate too many studies but are quicker to terminate unpromising research than smaller (stand-alone) biotech firms. In contrast, Belenzon and Berkovitz (2008a) find European evidence that innovation tends to be concentrated in business-groups and that business-group affiliates tend to engage in more innovation than comparable stand-alone firms.

While these studies do not necessarily offer contradictory evidence - as business-groups have a different governance structure than fully integrated conglomerates - they do suggest that the link between governance and innovation is likely to be complex and that more systematic evidence is required to have a better understanding on how governance affects innovation.

In this paper we offer a more complete picture of the link between governance and innovation by looking at a cross-section of innovating firms in the U.S. and in 15 European countries. In addition, we provide a broad conceptual framework that allows us to compare the relative strengths of standalone firms, conglomerates and business-groups in fostering innovation.

Building on existing theories of conglomerate internal capital markets, we emphasize the relative strengths of conglomerates in terms of cheaper internal R&D funding, better winner-picking, and lower stigma of failure, versus the stronger intellectual property rights for innovators in stand-alone firms.[1] Business-groups occupy a middle ground compared with conglomerates and standalones. These are fuzzier and more diverse organizational forms with potentially complex controlling stakes holding together a set of independently incorporated companies. Business groups may be entirely composed of privately held entities or may combine both privately held and publicly traded companies. Business groups may take the form of *pyramidal structures*, where a single controlling company has direct or indirect controlling stakes in multiple subsidiary companies, or business *alliances*, where the companies in the alliance are connected through interlocking stakes.

Business groups are rare in the U.S. and somewhat rare in the U.K., but they are omnipresent elsewhere in the world. Business groups have been associated with poor minority investor protection and inefficient rent extraction by controlling shareholders (see Johnson, La Porta, Lopez-de-Silanes, and Shleifer, 2000, and Bertrand, Mehta, and Mullainathan, 2002). They are often seen as a consequence of poor legal investor protections in emerging market countries, and also to some extent in developed 'civil law' countries. Accordingly, we model business groups as in Almeida and Wolfenzon (2006) and allow for inefficient diversion of funds by controlling shareholders from firms affiliated with a business group. Due to this inefficient diversion business groups involve greater inefficiencies than conglomerates or standalones, other things equal. However, business groups also have strengths in terms of cheaper internal R&D funding and a lower stigma of failure relative to stand-alone firms, as well as strengths in terms

[1] We mainly build on Gertner, Scharfstein and Stein (1994), Stein (1997) and Scharfstein and Stein (2000).

of stronger intellectual property rights for innovators relative to conglomerates.

An important basic premise of our analysis is that innovating firms tend to set up their corporate governance to implement an efficient environment to foster innovation. Thus, when the observed choice of corporate form is a conglomerate or a business group we assume that this is the revealed preferred choice of organization. In other words, a basic premise of our analysis is a *Coasian perspective* on firm organization. Thus, to the extent that a particular corporate form is especially well suited for innovative activities, we expect this corporate form to be more prevalent among innovative firms in a given industry than among non-innovating firms.

We base our analysis on a comprehensive data-set of both private and publicly traded American and European firms, and match all corporate patents granted by the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO) to these firms. We also single out firms that publish their research in academic journals. We have thus identified about 64.000 firms that hold at least one patent from the EPO or USPTO, or have published at least one scientific article in a science journal. Of these 64.000 firms, about 60% are American, 11% German, 8% British, 4% French, and 5% are Italian. We matched 880.000 USPTO, 615.000 EPO patents, and 205.000 scientific publications. 75% of USPTO patents and close to 40% of EPO patents are held by American corporation. Germany appears to be the most innovative European country while holding 12% and 20% of USPTO and EPO patents, respectively. For scientific publications, about 70% of the articles are published by U.S. corporations, 10% German, and 3% French and British.

Several surprising findings emerge from our analysis. First and foremost, while the overall distribution of USPTO patents by ownership structure in the whole sample is 18% standalones, 74% conglomerates, and 8% business-group affiliates, in the U.S. this distribution is skewed towards standalones and conglomerates, with 20% and 76% respectively of patents falling in these categories, and only 4% of patents being held by business group affiliates. In Europe, on the other hand, 20% of the patents are held by business-group affiliates, and 11% and 68%

respectively are held by standalones and conglomerates. A similar pattern emerges for EPO patents and scientific publications. There is also a wide variation in organizational form across European countries. While Germany appears to resemble the U.S. in terms of concentration of innovation in conglomerates (80%), French and Italian firms are clearly skewed towards business-group affiliates, with only 35% and 22% respectively of their patents being held by conglomerates.

Second, we distinguish between business-group affiliates that are wholly-owned by their parent company, which are more likely to be fully integrated, and affiliates that have minority shareholders. The presence of minority shareholders in an affiliate company establishes a separation between the affiliate and its parent company in terms of retained profits, patent holdings, and resource reallocation. Business groups with partially owned affiliates are therefore more decentralized corporate structures. Remarkably, in France 20% of innovation takes place in affiliates with minority shareholders, while only 1% of innovation takes place in such affiliates in the U.S. and Great Britain.

Third, the U.S. distribution of innovating firms is also heavily skewed towards publicly traded firms. Indeed, the fraction of patents held by publicly traded American corporations is above 60%, while this fraction is only about 40% in Europe. In some large European countries this picture is even more extreme. In France, only 9% and 18% of USPTO and EPO patents, respectively, are held by publicly traded firms, while in Italy these figures drop to as low as 3% and 7% respectively. Also, publicly traded innovating firms in Europe are more likely to belong to a business group, with more than 40% of innovating listed firms belonging to a business-group in France and Germany, compared with only 2% and 1% respectively in the U.S. and Great Britain.

Fourth, we find a substantial variation in organization structure across industries. Business groups tend to be concentrated in industries where innovation takes a longer time, is more uncertain, but has a higher payoff when it succeeds (such as pharmaceuticals and biotechnology). These innovative activities may be more vulnerable to hold-up problems and require greater protection of the intellectual property rights of the innovator. In contrast, conglomerates are more prevalent in industries with rapid, incremental, innovations (such as computer hardware and telecommunications) where the ability of conglomerates to identify the relevant innovation and to quickly redeploy assets may give this organizational form an edge over business groups. We find that European firms are strongly skewed towards business groups in the latter industries, while U.S. innovating firms take the conglomerate form in more or less the same proportion across all industries.

Our findings are broadly consistent with a *Coasian view* on firm organization form, which is to say that firms choose the corporate form that is best suited for fostering innovative activities. The alternative view in the literature is that organization form is chosen by entrenched managers, or controlling shareholders, to suit their best interests at the expense of minority shareholders and overall firm efficiency. By this latter view it is not obvious that one should see any systematic difference in organization form in a given industry and country across innovative and non-innovative firms. We examine whether innovative firms are disproportionately represented in a given organization category, using sales of about 3.5 million firms as our benchmark. We find that innovation is disproportionately concentrated in business-groups in the pharmaceuticals industry, and disproportionately concentrated in conglomerates in the telecommunications industry. This pattern is especially true in Europe, where there are fewer regulatory hurdles to the formation of business groups and hybrid corporate forms. It is not the case in the U.S., where conglomerates are generally preferred.

The remainder of the paper is organized as follows. Section 2 presents the theoretical framework, section 3 overviews the data, section 4 reports the main empirical findings and section 5 concludes.

2. A Simple Model

We set up a model with at least two business units, which can be stand-alone entities, divisions in a conglomerate firm, or units linked in a business group, with one parent company owning a controlling block in a separately incorporated firm.

1. Technological Assumptions

There are $N \geq 2$ business units with liquid assets $W_i \geq 0$ and a new *R&D* project. The R&D project has fixed costs $f > 0$ at date 1 and a probability of success $\theta(a)$ at date 2. The probability of success depends on how well the project is managed, or more formally, on which action $a \in \{0, 1\}$ the project's manager chooses. The project's value to the business unit conditional on success is given by $v(a) > 0$. A successful R&D project may also generate spillovers to other business units worth $s(a) \geq 0$. When the research is unsuccessful (with probability $(1 - \theta(a))$) it yields no financial return.

The project brings expected private benefits or costs to the managerial team undertaking it. The benefits may come in the form of improved human capital and knowledge, better future career prospects, enhanced reputation in the event of success. The costs may be the stigma of failure when the research is not successful. Without loss of generality we normalize the net benefits arising from simply undertaking the project to zero. We denote by $b > 0$ the private benefits that come with success and by $\psi > 0$ the private costs associated with the stigma of failure.

We shall assume that:

$$b\theta_1 - \psi(1 - \theta_1) < b\theta_0 - \psi(1 - \theta_0),$$

so that the expected net private benefits to the manager are highest when the manager chooses $a = 0$. Note that the latter inequality reduces to

$$(b + \psi)(\theta_0 - \theta_1) > 0,$$

and therefore holds if and only if $\Delta\theta \equiv \theta_1 - \theta_0 < 0$. We also assume that

$$(v_1 + b)\theta_1 - \psi(1 - \theta_1) - f > 0 > (v_0 + b)\theta_0 - \psi(1 - \theta_0) - f$$

These inequalities together with $\Delta\theta < 0$ mean that the innovative activity is equivalent to taking a higher risk, higher expected payoff actions. In other words, R&D activities are high risk, but also high reward activities. The above inequalities also mean that the R&D activity is worth undertaking if and only if the manager can be induced to choose the high risk, high reward, action $a = 1$.

To simplify the analysis we also restrict attention to parameter values such that $b\theta_1 \leq \psi(1-\theta_1)$. The manager's expected private costs from the stigma of failure when he chooses $a = 1$ are then greater than the private benefits from a successful innovation. Under this assumption the manager has to receive some form of financial incentive to be willing to undertake the risky innovative activity.

2. Governance Assumptions and Firm boundaries

We distinguish between three main types of firms: standalones, conglomerates (with wholly-owned affiliates) and business-groups with affiliates owned in part by minority shareholders.

A *standalone firm* is essentially a firm with a single business unit. Such a firm is run by a manager with an equity stake sufficient to align incentives and is monitored by a large blockholder, venture capitalist (VC), or creditor, who plays the role of an *active monitor* as in Holmstrom and Tirole (1994). A standalone firm is viable only if it is able to raise sufficient funds to finance the research, while preserving the manager's incentives to conduct the research and the monitor's incentive to monitor.

We assume that only a fraction η of the firm's value $v(a)$ can be pledged to raise external funds. The parameter $\eta \in (0, 1)$ represents the fraction of R&D cash-flow that is *capitalizable* by the firm. It provides a simple measure of the financial development of a country. The higher is η the more financially developed a country is. We assume that capital markets are perfectly competitive for the pledgeable part of firm value and for simplicity we normalize the equilibrium required risk-adjusted return to zero.

Following Holmstrom and Tirole (1994) we also assume that the *timing* of the contractual relation between investors in the firm, the VC monitor, and the entrepreneur is as follows:

1. following an injection of funds in the firm by investors, the monitor moves first by choosing

whether to engage in costly monitoring or not;

2. the R&D project manager moves second by choosing whether to take action $a = 0$ or $a = 1$, having observed whether the active monitor is monitoring or not;

3. the R&D project either succeeds or fails;

4. if it succeeds the proceeds from the project are distributed to all investors and the manager.

Suppose that the active monitor decides to monitor the manager and incurs the monitoring cost $m > 0$. Then as in Holmstrom and Tirole (1994), we assume that the manager's net private benefits are lowered by a fraction $(1 - \lambda)$, where $\lambda < 1$.

The manager must be incentivized to choose $a = 1$. If his financial stake in the project, α, is large enough he will choose $a = 1$ even though his private benefits are higher for $a = 0$. Formally, the manager's stake α must be such that the following incentive compatibility constraint holds:

$$(\alpha v_1 + \lambda b)\theta_1 - \lambda\psi(1 - \theta_1) \geq (\alpha v_0 + \lambda b)\theta_0 - \lambda\psi(1 - \theta_0)$$

or

$$\alpha\Delta V + \Delta\theta\lambda(b + \psi) \geq 0.$$

where $\Delta V \equiv (v_1\theta_1 - v_0\theta_0)$ and $\Delta\theta = \theta_1 - \theta_0$. [2]

If there is no monitoring, on the other hand, the incentive compatibility constraint is: [3]

$$\alpha\Delta V + \Delta\theta(b + \psi) \geq 0.$$

Monitoring is beneficial if two conditions are satisfied.

First, it must be the case that the firm cannot get sufficient financing in the absence of monitoring. That is, the firm should not be able to invest in R&D, by using all its internal funds W_i and raising $(f - W_i)$ from outside investors, while at the same time granting sufficient

[2] Note that under our assumptions ΔV is strictly positive and $\Delta\theta$ is strictly negative.

[3] Since $\Delta\theta < 0$ the incentive constraint is clearly harder to satisfy with no monitoring than under monitoring.

financial incentives to the entrepreneur to choose $a = 1$ even though there is no monitoring. Therefore, a first condition is that:

$$(1-\alpha)\eta v_1\theta_1 < f - W_i$$

for any α such that

$$\alpha\Delta V + \Delta\theta(b+\psi) \geq 0,$$

or

$$[1 + \frac{\Delta\theta(b+\psi)}{\Delta V}]\eta v_1\theta_1 < f - W_i.$$

Second, the firm must be able to get financing when there is monitoring. The active monitor has an incentive to monitor and incur the monitoring cost m as long as his stake β in the firm's profit is large enough that $\beta\eta\Delta V \geq m$. In exchange for the stake $\beta = \frac{m}{\eta\Delta V}$, which just ensures that he will monitor, the active monitor is willing to invest an amount equal to his expected equilibrium net return: $\beta\eta v_1\theta_1 - m$. Therefore, the standalone firm is viable under monitoring if

$$(1-\alpha-\beta)\eta v_1\theta_1 \geq f - W_i - \beta\eta v_1\theta_1 + m,$$

or, substituting for α and β if:

$$(1 + \frac{\Delta\theta\lambda(b+\psi)}{\Delta V} - \frac{m}{\eta\Delta V})\eta v_1\theta_1 \geq f - W_i - m(\frac{v_1\theta_1}{\Delta V} - 1).$$

Rearranging, this condition reduces to:

$$[1 + \frac{\Delta\theta\lambda(b+\psi)}{\Delta V}]\eta v_1\theta_1 \geq f - W_i + m.$$

Clearly, for η large enough, and m and λ small enough this condition will be satisfied given our assumption that

$$v_1\theta_1 > f.$$

A *conglomerate firm* operates $n \geq 2$ business units that are wholly-owned subsidiaries. It has corporate headquarters that make investment and R&D decisions for all divisions. A key feature of conglomerate firms is that profits of subsidiaries are channeled to headquarters, who report consolidated earnings to the firm's shareholders. Divisional managers typically cannot be rewarded based on their division's profit, and their incentive pay-component is generally based only on conglomerate profits and stock price. Moreover, divisional managers don't own the intellectual property they create, unless they negotiate a contract which explicitly gives them the right to any innovation they create. [4]

On the other hand, divisional managers may be closely monitored by headquarters. Another advantage of undertaking research in a conglomerate is that failure can be hidden to some extent inside the firm, so that there is a lower stigma of failure. Conglomerates also develop *winner picking* skills, and benefit from R&D spillovers on other divisions.

For our formal analysis we assume that conglomerate firms are composed of only two divisions, A and B. We also simplify the governance of conglomerate firms to the CEO's role in picking winner R&D projects and to the CEO's active monitoring of division managers. We model winner picking by assuming that a project selected by headquarters has a probability of success $\rho\theta(a)$, where $\rho \geq 1$. We model CEO monitoring by letting the CEO monitor division managers $j = A, B$ at cost μ and thereby lowering division managers' private benefits by a fraction $(1-\lambda)$. If the divisional manager's research is successful, however, it is owned by the firm. Thus, division managers have lower powered incentives to pursue R&D in conglomerates. [5] In our model, a divisional manager can only extract a small share γ of the direct value of the innovation by, for example, threatening to leave and pursue his research at another firm. Thus, the divisional manager's incentive constraint for choosing action $a = 1$ in a conglomerate is:

$$(\gamma v_1 + \lambda b)\rho\theta_1 + (1-\rho\theta_1)\lambda\psi \geq (\gamma v_0 + \lambda b)\rho\theta_0 + (1-\rho\theta_0)\lambda\psi,$$

or

$$\gamma\Delta V + \Delta\theta\lambda(b+\psi) \geq 0.$$

[4] Such contracts are not common and even when a contract grants intellectual property rights to the innovator it is difficult to enforce.

[5] Divisional managers may get a share of conglomerate profits, but due to moral hazard in teams problems, they will have lower powered incentives than if they received a share of their own division's profits. For simplicity, we ignore the financial incentives from shares in conglomerate profits.

Finally, conglomerates have the financing advantage of drawing on the sum of liquid assets of both divisions, $(W_A + W_B)$, to fund a division's R&D project. To summarize, in our model a conglomerate picks the most promising R&D project from the divisions, thus ensuring a probability of success of $\rho\theta_1$ in equilibrium. It finances the project entirely with its own funds $(W_A + W_B)$ and it incurs monitoring costs μ. Thus, the conglomerate's expected return is given by:

$$(1 - \gamma)v_1\rho\theta_1 - f - \mu + W_A + W_B$$

provided that it can induce the divisional manager whose R&D project is picked to choose action $a = 1$. Should γ be so low that

$$\gamma < \frac{\Delta\theta\lambda(b + \psi)}{\Delta V}$$

then the division manager will choose $a = 0$, in which case we assume that the conglomerate will not pick any R&D projects.

A *business-group* of $n \geq 2$ firms is similar to a conglomerate firm. It has a controlling hub akin to corporate headquarters and multiple divisions. The key differences with a conglomerate are that: *i)* the business units are not wholly owned subsidiaries, but rather are independently incorporated companies controlled by the group's majority shareholders through a controlling stake; *ii)* earnings of business units are not consolidated, and ownership of intellectual property remains with the innovating business unit; *iii)* R&D project selection is more decentralized, so that the group's hub plays less of a winner picking role. The group mainly plays the role of an internal capital market to fund R&D investments.

We denote by φ the ownership share of the group and $(1 - \varphi)$ the share owned by minority shareholders. An important potential source of inefficiency in business groups is the separation of ownership and control of business units. This separation can give rise to inefficient diversion of business unit earnings by the controlling shareholders. We model this diversion as in Almeida and Wolfenzon (2006) by allowing the controlling shareholders to "divert" d of earnings from a unit in which they have a stake φ at a deadweight cost of

$$k(d) = \frac{1}{2}\kappa d^2.$$

Group owners then choose d to maximize:

$$\varphi(v - d) + d - \frac{1}{2}\kappa d^2,$$

where ν denotes the business unit's earnings. As is easily established, the optimal amount of diversion and the deadweight cost of diversion are then respectively:

$$d(\varphi, \kappa) = \frac{1-\varphi}{\kappa} \text{ and } k(d(\varphi,\kappa)) = \frac{(1-\varphi)^2}{2\kappa}.$$

The earnings retained in the firm–$(v - \frac{1-\varphi}{\kappa})$–can be shared between the division manager and all the owners. Thus division managers can be incentivized as in standalones based on the non-diverted earnings. Moreover, the business unit manager's private benefits can be reduced through monitoring by the group's controlling owners.

As the literature on business groups has emphasized, the diversion of earnings by controlling shareholders reduces the efficiency of business groups relative to stand-alone firms or conglomerates. [6] The pervasiveness of business groups around the world (with the important exceptions of the U.S. and Great Britain) suggests, however, that there is also a countervailing efficiency improving role of business groups. [7] We argue that the efficiency gain of business groups is due to the stronger intellectual protection given to innovators in business units affiliated to business groups, who can retain (partial) ownership of their patents.

To summarize, business groups combine the R&D incentive benefits of stand-alone firms with the internal capital market benefits of conglomerates. Given equal R&D incentives, however,

[6] There can also be diversion of funds from conglomerates with separation of ownership and control. For simplicity we ignore this form of diversion in our model.

[7] While, some commentators simply explain the existence of business groups as an inefficient outcome caused by managerial entrenchment, others point to the value adding role of business groups as providers of a substitute source of funding for investment in environments where external capital markets are inefficient due to inadequate investor protection. Thus, the prevalence of business groups in emerging market countries is seen as a necessary but transitory consequence of the underdevelopment of securities markets in these countries. However, as our evidence highlights, business groups are also prevalent in advanced countries, with developed securities markets and strong investor protections. Moreover, as we show, these groups tend to be both very competitive and innovative.

business groups are less efficient than conglomerates, as they involve both inefficient diversion of funds and less effective winner-picking.

3.Assumptions on external legal environment

Besides η (the fraction of the value of innovations that is capitalizable) we introduce three other key parameters to capture the external legal environment: τ an intercompany dividend tax, γ the R&D project manager's bargaining power, and ψ the stigma cost of failure. As we argue in the next section, the main comparative advantages of the U.S. relative to the EU are that U.S. securities markets free up a higher η and γ. Moreover, U.S. entrepreneurial culture and bankruptcy laws also result in a lower ψ. Against these comparative advantages the EU's main advantage is a lower τ.

3. Model Analysis

We divide the model analysis into two parts. We begin by considering the main tradeoffs in organizational form keeping the external legal environment fixed. In a second step we do a EU-US comparative analysis by analyzing how changes in the parameters (η, τ, ψ) affect the equilibrium distribution of R&D across organizational forms.

3.1. Main tradeoffs within a given legal environment

We consider in turn the choice between undertaking R&D in a stand-alone unit or inside a conglomerate firm, the pros and cons of a business-group and a conglomerate structure, and finally the choice between stand-alone and affiliation to a business-group.

3.1.1. Stand-alone firm vs. Conglomerate: the costs and benefits of internal capital markets

Consider the funding of R&D projects in a conglomerate with two business units, A and B. To facilitate comparisons with a stand-alone firm we assume that only one of the two units has a potential research project, say division A. We also assume that the conglomerate has sufficient internal funds or capital to be able to fund the project without raising external funds, $(W_A + W_B) \geq f$. A conglomerate has lower costs of monitoring and greater winner-picking skills, so that it will be more efficient at R&D as long as it can provide adequate incentives to choose action $a = 1$ to its divisional managers. Therefore, R&D is organized in a conglomerate whenever divisional managers have sufficient incentives to choose action $a = 1$. That is, whenever γ is large enough that:

$$\gamma + \frac{\Delta\theta\lambda(b+\psi)}{\Delta V} \geq 0.$$

If γ is too small then R&D may be organized in a standalone firm provided that enough external funding can be obtained, or:

$$[1 + \frac{\Delta\theta\lambda(b+\psi)}{\Delta V}]\eta v_1 \theta_1 \geq f - W_i + m.$$

In Figure 1 below we describe the parameter regions for which R&D takes place in respectively a standalone firm (SA) and a conglomerate (CL) in $(\Delta V, f - W_i + m)$ space. The function $h(\Delta V)$ is given by

$$h(\Delta V) \equiv [1 + \frac{\Delta\theta\lambda(b+\psi)}{\Delta V}]\eta v_1 \theta_1$$

and the vertical line $\Delta V_{\#}$ is

$$\Delta V_{\#} = -\frac{\Delta\theta\lambda(b+\psi)}{\gamma}.$$

For all values of $\Delta V \geq \Delta V_{\#}$ the incentive constraint for $a = 1$ in conglomerates is satisfied and R&D is organized in a conglomerate. For $\Delta V < \Delta V_{\#}$, R&D is not efficient in a conglomerate, but it may be sustainable in a standalone firm provided that the parameter values for $(\Delta V, f - W_i + m)$ lie in the area (SA); that is, provided that $(f - W_i + m) \geq m$ lies below $h(\Delta V)$. In situations where the hold-up problem is so severe that R&D projects cannot be undertaken efficiently in a conglomerate, innovators may still be able to undertake their R&D project in a standalone firm provided that the external financing needs of the R&D project

$(f - W_i)$ are sufficiently low, and/or the costs of monitoring the innovator (m) are sufficiently low.

Simple comparative statics results can be inferred from Figure 1. In particular, any upward shift in the function $h(\Delta V)$ and any rightward shift in $\Delta V_{\#}$ will increase the region of R&D in standalones relative to conglomerates. In other words, an increase in $\eta v_1 \theta_1$ makes R&D easier to sustain in standalones and an increase in $|\Delta\theta|$ makes it harder to sustain in conglomerates. This suggests that high-risk-high-payoff R&D (with high $|\Delta\theta|$ and high $\eta v_1 \theta_1$ is more likely to be found in standalones than conglomerates.

Insert Figure 1 here

The role of Venture Capital (VC) in the US is mainly to target these types of innovations. As we explain in the next section, we believe that in the EU in contrast to the US the role of VCs is partly filled by business-groups. The reason is that in the EU the capitalization of R&D (as measured by η) is lower than in the US. Moreover the stigma of failure ψ is also higher.

3.1.2. Conglomerate vs. Business Group: internal capital markets, the cost of diversion and the intercompany dividend tax and intellectual property rights protection

Business groups can provide better protection of intellectual property rights of its business units than conglomerates but they are exposed to inefficient diversion of funds by their controlling owners. Suppose that unit A is combined in a group with unit B, and as before suppose that $(W_A + W_B) \geq f$. Let φ_A denote the group's ownership share in affiliate A and suppose that φ_A is large enough that the group has adequate incentives to actively monitor the manager of affiliate A. Recall that for every \$1 generated by affiliate A a fraction $\frac{1-\varphi_A}{\kappa}$ is diverted to the group and a fraction $\left(1 - \frac{1-\varphi_A}{\kappa}\right)$ is retained by the affiliate. Therefore, if the manager of A is to effectively undertake an R&D project (i.e. to choose $a = 1$) his stake must be at least equal to

$$\alpha = -\frac{\Delta\theta\lambda(b + \psi)}{\Delta V \left(1 - \frac{1-\varphi_A}{\kappa}\right)}.$$

Setting $\alpha = 1$, its maximum possible value, it is then straighforward to see that a business group with equilibrium diversion of funds $\frac{1-\varphi_A}{\kappa}$ is able to foster efficient R&D in unit A as long as $\Delta V \geq \Delta V_*$ given by: [8]

$$\Delta V_* = -\frac{\Delta\theta\lambda(b+\psi)}{\left(1 - \frac{1-\varphi_A}{\kappa}\right)}.$$

Since business-groups involve costs which are not incurred by conglomerates they will only be the chosen organization form for R&D activities when adequate R&D incentives cannot be provided in conglomerates, or when $\gamma < \frac{1-\varphi_A}{\kappa}$ and $\Delta V \in (\Delta V_*, \Delta V_{\#})$.

But, even for these parameter values business groups may not be the chosen organizational form if the tax burden in terms of intercompany dividend taxation exceeds the benefit from greater R&D incentives. Intercompany dividend taxes amount to

$$\tau\varphi_A\left[\left(1 - \frac{1-\varphi_A}{\kappa}\right)v_1 - f\right]$$

in our model. Indeed, the reported (and undiverted) revenues by affiliate A in the event of a successful innovation are given by $\left(1 - \frac{1-\varphi_A}{\kappa}\right)v_1$. Therefore the realized profits are $\left(1 - \frac{1-\varphi_A}{\kappa}\right)v_1 - f$. The business-group obtains a share φ_A of realized profits on which it pays a marginal intercompany dividend tax of τ. If the tax rate τ is too high it may not be worthwhile for the group to fund the R&D project in affiliate A. [9]

3.1.3. Business Group vs. Stand-alone: diversion costs and the benefits of internal capital markets

The main advantage of Business groups over standalones is that they are able to tap the internal capital of the entire group to fund new R&D projects. Given that business groups also involve

[8] Note that the manager's financial stake generally has to be higher than for a stand-alone, as a fraction $\left(\frac{1-\varphi_A}{\kappa}\right)$ of the financial value of the innovation is siphoned off by the group. But note also that the higher is the marginal cost of diversion κ, the less funds are diverted and therefore the lower is the manager's financial stake necessary to incentivize him to do research. Similarly and somewhat paradoxically, the higher is φ_A–the group's stake in affiliate A–the lower is the manager's financial stake necessary to incentivize him.

[9] Intercompany dividend taxes are not the only cost of setting up a partially integrated business group. Other tax rules, company registration rules, accounting rules concerning the consolidation of accounts and regulations limiting the flexibility of holding company structures may result in other costs. Thus, for example in the US the Public Utility Holdings Company Act of 1935 has substantially limited the scope for business groups in the energy sector.

diversion costs, R&D will only be undertaken in a business group if it is not possible to fund R&D in a standalone using costly external financing. This is illustrated in Figure 2 below.

Insert Figure 2 here

Again, simple comparative statics results can be seen from this figure: an upward shift in $h(\Delta V)$ increases the region of R&D in standalones and reduces the region in business groups (BG). There is R&D in business groups for $\Delta V \geq \Delta V_*$, only when it is not feasible in standalones. When there is a rightward shift in ΔV_*, R&D in business groups is less likely. Such a rightward shift may occur if κ is lower, so that there is more potential for diversion of funds. We therefore expect the share of R&D taking place in business-groups across European countries to be inversely related to the ease of diversion allowed by the corporate legal environment in each country.

3.1.4. Business Group vs. Stand-alone and Conglomerates: the benefits of internal capital markets diversion costs and intellectual property rights protection

We can combine the comparison of the three organizational forms into a single figure (Figure 3) and obtain the following broad comparative statics insights for fixed country parameters (η, ψ, τ).

Conglomerates will be a higher fraction of innovating firms when there is a leftward shift in $\Delta V_\#$. This shift may be due to either a higher γ or a lower $\Delta\theta$. One may expect industries with many, incremental, innovations to have both higher γ (through greater implicit incentives) and lower $\Delta\theta$. These industries are therefore more likely to be dominated by conglomerates. Their ability to quickly identify the relevant innovation and to quickly redeploy assets gives these organizational forms an edge over business groups and standalones. Moreover, in these industries conglomerates can credibly offer adequate incentives for in house R&D without granting formal ownership rights to the innovators.

Business groups are likely to be more prevalent in industries with a slower and more fundamental innovation cycle, where $\Delta\theta$ is higher (and γ lower). These organizational forms may not be the most efficient in picking winners but they are able to provide better intellectual ownership protection. To the extent that it is harder to divert funds (κ is higher) we should also see more innovating business groups, as ΔV_* is then lower. But a more efficient VC sector with lower monitoring costs (m) and/or lower costs of external funds will tend to reduce the dominance of business groups in these industries.

In general, we expect industry variation in the share of business groups among innovating firms across industries. However, we also expect this variation to be smaller in countries where the absolute advantage of one organizational form due to the country's regulations and laws is stronger.

Insert Figure 3 here

3.2. Main EU-US comparative predictions

Business groups have one major comparative advantage in continental European countries relative to the US: the general absence of an intercompany dividend tax. In addition, there is more of a stigma of failure in these European countries and financial markets are also somewhat less developed. For all these reasons, we expect R&D to be concentrated in higher proportion in business-groups relative to conglomerates and standalones in continental Europe than in the US. For the same reasons, we expect to find more R&D activity in publicly traded firms in the US than in the EU. These simple predictions are indeed borne out in the data as we show below.

4. Data

Our paper combines data from several sources: (1) ownership data from **Amadeus** for European firms and from **Icarus** for American firms (both are provided by BvDEP), (2) information on patents from the United States Patent and Trademark Office (**USPTO**) and the European Patent Office (**EPO**), and (3) scientific publications from **Thomson Web of Knowledge**.

4.1. Ownership

The Amadeus and Icarus data sets contain detailed information on direct ownership links between firms. We sort firms into four different categories based on their ownership structure: (i) standalones, (ii) conglomerates, (iii) wholly-owned business group affiliates, and (iv) partly-owned business-group affiliates.

A firm is categorized as a *standalone* if it has a single line of business and no parent company, and as a *conglomerate* if it has more than one line of business. Many innovating firms in our sample are *wholly-owned affiliates* – they have a parent company that owns 100% of their shares – and it is not entirely obvious how one should categorize these firms. In some cases a wholly-owned affiliate is an independent economic unit, but in other cases, it acts more like a division in terms of its retained profits and IP protection. We distinguish between the two cases in the following way. We compute the share of assets that are held by the company at the apex of the organization out of the total assets the organization holds. In case this share exceeds a high-enough threshold (80%), we assume the organization is centralized and categorize all of its wholly-owned affiliates as divisions.[10] If the organization's assets are decentralized and spread across many affiliates, we assume the wholly-owned affiliates are independent, and classify them under the business group category (a separate category named *wholly-owned business group affiliates*). In the context of our model there is not much of a difference between a division of a conglomerate and a wholly-owned subsidiary. There is a significant difference, however, between a division of a conglomerate and a *partly-owned business group affiliate* (our fourth category), as the latter has both a parent-company controlling-shareholder and other minority shareholders. As our model highlights minority shareholders in business-group affiliates play a central legal and governance role in protecting intellectual property owned by the affiliate firm. Business groups establish an intra-company separation of ownership and control. This separation puts minority shareholders at risk of expropriation by

[10] If the apex company reports only consolidated accounts, we infer the *unconsolidated* assets held by the apex company by subtracting the aggregated assets of all affiliates from the consolidated assets.

majority shareholders, as the literature on business groups has emphasized. However, European Corporate Group Law imposes strict provisions on the reallocation of resources between group affiliates, which provide an intellectual property protection to researchers in affiliate firms. These provisions practically make the group affiliate independent in terms of its assets, patents, and retained profits. Unlike for group affiliates, researchers in conglomerate divisions do not have the same legal protection of intellectual property. Conglomerate headquarters can freely reallocate assets, funds and IP rights across different units with no legal restriction or threat of litigation by division stakeholders. Our comparative analysis focuses mostly on the relative prevalence of partly-owned business group affiliates, conglomerates, and standalones.

To fully characterize the ownership structure of firms in our sample, we use ownership links information for private and public American and European firms from the ownership section of the 2008 version of Icarus and Amadeus. To ensure that all ownership links truly represent control, we make the following assumptions:

1. for private subsidiaries, we keep only links where the shareholder has at least 50% of the voting rights, and

2. for public firms we keep only links where the shareholder has at least 20% of the voting rights. These two assumptions leave us with close to one million ownership links.[11]

3. to infer group structure from these links we use the algorithm developed and described in Belenzon and Berkovitz (2008a). This algorithm constructs corporate ownership-chains and groups together firms controlled by the same ultimate owner. Appendix A.1 provides more information about the ownership algorithm and group construction.

[11] Erring on the side of caution, we define control of a private firm as owning at least 50% of the firm's voting rights (excluding non-voting shares). Following previous literature on public firms (La Porta et al. 1999; Faccio and Lang, 2002; and others), which have a more dispersed ownership, we set the threshold for control of a public firm at 20%. All our results are robust to different numbers for these thresholds.

4.2. Patents and Scientific Publications

To create a firm-level measure of innovation, we examine patent based indicators of technological advances by firms.[12] We construct a novel database of European and American firm patents by matching all granted patent applications from the USPTO and EPO to the complete set of firms in Amadeus and Icarus. Our main source of information for patents granted between 1969 and 2002 is USPTO data as assembled in the NBER patent file.[13] Because our ownership data is cross-sectional for 2008, we also include recently issued patents so as to address potential concerns that the ownership structure we observe is not contemporaneous with the generation of patents in our sample. We update the NBER patent file for 2007 by extracting directly from the USPTO website all patents granted between 2003 and 2007, adding about 750.000 patents to the original NBER patent data.[14] For the EPO, our main information source is the 2007 publication of the PATSTAT database, which is the standard source for European patent data and is published by the EPO. This database contains all European patent applications and granted patents from the beginning of the EPO system in 1978 to 2007. For each USPTO and EPO patent document we have information on the name of the firm to which the patent is assigned as well as the firm's address. We match the name and the address fields from the patent document to the name and address fields in Amadeus and Icarus. Appendix A.2. provides details about the matching procedure.

Another innovation indicator is scientific publications in academic journals (Cockburn and Henderson, 1998). We also look at scientific publications for two main reasons. First, not all inventions are patentable, and even if they are, patents can vary substantially in quality. Scientific publications, on the other hand, are not subject to the patentability selection problem,

[12] We use patents data to measure innovative activity, because we do not have direct information on R&D expenditures for private firms. For a discussion on the use of patents data as a measure of inventive activity, see Griliches (1990).

[13] This database is described by Hall, Jaffe and Trajtenberg (2001) and Jaffe and Trajtenberg (2002).

[14] The general pattern of results holds when focusing on recently granted patents. Table A3 reports the distribution of patents by country and organization form for USPTO patents that were granted between 1996 and 2006. Only 1 percent of the American patents are held by partly-owned affiliates, as compared to 12% and 11% of French and Italian patents, respectively.

and they are generally regarded as indicators of high-quality research. Second, while patents typically represent more *directed* and *incremental* research, scientific publications tend to be the result of more basic and risky research (Belenzon and Patacconi, 2009). To measure the publication activity of our sample firms, we develop a data set of firm scientific articles. The world's largest source of information on scientific publications is Thomson's ISI Web of Knowledge, which includes publication records on hundreds of international journals in the 'hard' sciences. Each publication has an address field which contains the authors' affiliation. We match all firms (patenting and non-patenting) by name to the complete ISI database using the author affiliation name and address fields.[15][16]

5. Empirical evidence

Several striking findings emerge from our analysis, as summarized in tables 1-3. First, while the overall distribution of patents by ownership structure in the whole sample is 18% standalones, 74% conglomerates, and 8% business-group affiliates, in the U.S. this distribution is skewed towards standalones and conglomerates, 20% and 76% of patents fall in these categories, and only 4% of innovating firms are affiliated with a business-group. In Europe, on the other hand, 20% of patents are held by business-group affiliates. A similar pattern emerges for EPO patents and scientific publications. There is also a substantial variation in organizational form among European countries. Germany resembles the U.S. in some ways, as 80% of its patents are held

[15] It is important to note that we make no restrictions on the availability of accounting information for our sample firms. That is, every firm that was matched to the patent or publications data sets is included in our analysis. While the coverage of accounting information is likely to vary across countries, especially for very small firms, the coverage of names and addresses is rather constant across countries regardless of firm size. The general pattern of results continues to hold when we exclude firms for which we have no accounting information, or firms with less than 20 employees (this threshold tends to reduce differences in coverage across countries).

[16] Although we do not exclude firms from our sample if they do not report financial information, some interesting observations emerge from examining only firms for which financial information is available. Standalone firms tend to be substantially smaller than conglomerates and partly-owned affiliates, while conglomerates and partly-owned affiliates do not differ much on size. The average standalone firm has 177 employees (a median of 20), and about $100 million in annual sales (a median of $8.3 million). The average conglomerate has 3.650 employees (a median of 136), and $918 million in annual sales (a median of $14.3 million). The average partly-owned affiliate has 2.400 employees (a median of 214), and about $1 billion (a median of $65 million). Comparing conglomerates to partly owned-affiliates, the different in mean size (annual sales) is not significant (a *t-stat* of -0.482).

by conglomerates and only 9% by business-group affiliates[17]. In contrast, France is heavily skewed towards business-groups, where only 35% of patents are held by conglomerates.

Second, the presence of minority shareholders in innovating affiliates varies enormously across countries. While in the U.S. and Great Britain only 1% of innovation takes place in affiliates with minority shareholders, about 20% and 15% of French and Italian patents, respectively, are concentrated in affiliates with minority shareholders.

Third, the U.S. patents distribution is heavily skewed towards publicly traded firms (table 2). Indeed, the fraction of patents held by publicly traded U.S. corporations is above 60%, while this fraction is only about 40% for European firms. This percentage also varies substantially across European countries: in Germany, 57% of USPTO patents are assigned to publicly traded firms; in contrast, in France and Italy only 9% and 3% respectively of patents are assigned to public firms. Moreover, a large share of publicly traded firms in continental Europe belong to business groups: in France and Germany this percentage is above 40, while in the U.S. and Great Britain only 2% of publicly traded firms belong to a business group. Yet, in the U.S. there is also a higher percentage of standalone publicly traded firms compared with continental Europe and Great Britain.

Table 3 further highlights the differences in the distribution of patents by ownership type across countries. Panel A describes the top 20 American innovating firms. Leading the list is IBM with more than 43.000 USPTO patents. All American firms in this table have the same ownership structure: they are all conglomerates and are publicly traded. Panel B focuses on British firms, which resemble the American conglomerate structure.[18] Panel C examines

[17] The German data on conglomerate dominance in R&D, however, is driven mostly by four large firms: Siemens, Robert Bosch, Bayer and BASF. These conglomerates hold about 60% of all German patents. Excluding these organizations, business groups account for 21% of German patents, and conglomerates account for 52%.

[18] Ownership structure in Great Britain differs somewhat from that in the U.S. While the parent company of a British organization is usually publicly traded, all innovative affiliates in our sample are private companies. A good example that illustrates this rather unique structure is GlaxoSmithKline. This pharmaceutical giant has three of its affiliates appearing in the top 20 most innovative firms (Beecham, Glaxo Group, and SmithKline Beecham). Each firm is wholly owned by GlaxoSmithKline holding-company. While the holding company is publicly traded, none of the innovative affiliates are. Glaxo has two headquarters - GlaxoWellcome, and SmithKline Beecham, and a holding company that wholly-owns the whole organization. We classify Glaxo as a

the leading innovating firms in France. More than half of these companies are business group affiliates, where seven of these have minority shareholders. Only 40% of the firms are publicly traded. For Germany (panel D), 20% of the German firms are partly-owned business-group affiliates. Lastly, 40% of the Italian firms are partly-owned business group affiliates (panel E), and only one Italian firm is publicly-traded.[19]

Another interesting observation relates to differences in patent assignment in conglomerates and business-groups. U.S. conglomerates usually assign patents to headquarters or to special central intellectual property management divisions, and not to the division where patent was generated. For example, IBM assigns almost all patents its divisions generate to its New-York headquarters (as indicated by the assignee name on the patent records)[20]. Other examples of large conglomerates that adopt a central patent management structure include General Electric (where 21,830 out of 22,348 of GE's patents are assigned to its Global Research Center division in New-York), and 3M (where 10,640 out of the 10,806 of 3M's patents are assigned to its headquarters, and the remaining patents are assigned to the wholly-owned IP management subsidiary 3M Innovative Property).

In contrast, business-groups have a decentralized patent assignment. We hypothesize that the presence of minority shareholders makes it difficult to simply transfer IP assets from the inventing to the controlling firm. In France, for example, L'Oreal holds 3,135 USPTO patents, out of a total number of 4,882 patents assigned to the whole Nestle group. Assigning L'Oreal's patents to Nestle would be considered an expropriation of the rights of minority shareholders of L'Oreal. The transfer of patents to the controlling entity requires some form of valuation and compensation of shareholders of the originating firm. This is likely to be a difficult transaction,

conglomerate although it has two headquarters, and a holding company at the apex.

[19]In table 3 we do not control for firm age, which means that older firms are more likely to appear on the list of innovative firms than younger ones. We examine the robustness of our findings by looking only at recent patenting activity. Our list of most innovating firms does not appear to be very sensitive to firm age. For example, the largest patentees in the USPTO between 2002 and 2006 are IBM (16.270 patents), Micron Technology (8.383 patents), Intel (7.729 patents), Siemens (7.023 patents), and Robert Bosch (5.870 patents).

[20]Interestingly, the pattern of scientific publications assignments is different than that of patent assignments. Where all IBM's patents are assigned to headquarters, academic publications are always assigned to IBM's research centers, mostly in Yorktown Heights New-York, Austin Texas and LA.

which is why patents mostly remain with the originating firm.

Insert Tables 1-3 here

Why do we observe a high concentration of business-groups in Europe, but not in the U.S.? Based on the history of business-groups in the U.S., a leading explanation in our view is the tax treatment of intercompany dividends. These have been taxable in the U.S. since the great depression, but are generally not taxable in continental European countries. Under the U.S. tax system, dividend income transferred from a subsidiary to the parent company is subject to a 7.5% tax. A similar tax does not exist in Europe. As described by Morck (2005), the U.S. tax reform of the 1930's was a response to the corporate scandals of the late 1920s, and the Roosevelt administration's belief that the proliferation of affiliate firms in business-groups have made these groups very opaque to outsiders, thus creating major governance, tax avoidance, market power, and political influence problems.

In addition to introducing the inter-company dividend tax, the U.S. congress also abolished consolidated tax filings for business-groups, eliminated capital gains taxes on liquidated controlled subsidiaries, and banned large pyramidal groups for controlling public utility companies (the Public Utilites Holdings Company Act or PUHCA of 1935). These policies impose a high penalty on organizing innovation in business-groups in the U.S. Thus, one would expect to observe more business-groups, on average, in Europe, especially in industries where group governance benefits are substantial.

5.1. Comparative analysis

Our theoretical analysis points to several predictions concerning the choice of organizational form, in terms of both the country's legal environment and financial development, and also the nature of the innovation cycle in each industry. Hereafter the analysis is mostly based on the number of EPO patents, where all findings are robust to using USPTO patents and scientific publications.

5.1.1. Comparison across countries

Three key country variables are likely to affect the choice of organizational form: (i) the capitalization value of R&D projects, (ii) the deadweight cost of diverting funds from business-group affiliates, and (iii) the presence or not of intercompany dividend taxes and other regulatory constraints on the formation of business group. We take as a simple measure of capitalization of future cash flows the ratio of the country's stock market capitalization and GDP. Our main prediction is that innovators are more likely to undertake their R&D project in a standalone firm when they are able to raise more funds by capitalizing a bigger fraction of the innovation's expected value. Similarly, in countries where the diversion of funds from affiliates is harder we expect to see more R&D activity organized in business group affiliates. Finally, countries with higher intercompany dividend taxes and more regulatory constraints on business group will have less R&D activity organized in business group affiliates.

Table 4 summarizes general findings from the cross-country comparison. We rank countries according to the three-year average ratio of stock-market traded value to GDP (Beck et al., 2000, 2007). As expected, the share of patents held by public firms is much higher in the top financial development quartile than in the lowest one (63.1% versus 18.0%). We also expect a higher prevalence of standalones in countries with higher capitalization ratios. Interestingly however, our findings are only partially consistent with the theory. While, as expected, standalones are more prevalent than business-groups in the high-capitalization countries, they are also more prevalent than conglomerates in low-capitalization countries. Business groups are much more prevalent in low-capitalization countries (20.6% versus 1.6% of the patents are held by partly-owned affiliates in low and high capitalization countries, respectively). This finding is consistent with the view that business-groups substitute for missing financial markets in fostering innovation. [21]

[21] Note that the reverse causality may also explain this outcome, if the existence of business-groups impedes the natural development of financial markets. Belenzon and Berkovitz (2008b) address this causality issue in the following way. They analyze a key channel through which financial development affects group affiliation - internal capital markets. If firms form business groups to create a substitute for underdeveloped financial markets, we would observe a higher probability of group affiliation among firms that operate in industries where

We proxy the cost of diversion of funds from affiliates with the anti-directive index developed by La Porta et al. (1997). This index measures the overall strength of a country's minority shareholders protection laws. In countries where these laws are stricter, it is more costly to divert funds from one affiliate to another. Innovation in business groups should be more prevalent in countries with stronger minority shareholders protection laws. Surprisingly, we do not find support for this prediction. There is in fact a higher share of innovation in business-groups in countries with relatively weak minority protection laws (9.3% in the lowest minority protection quartile versus 1.5% in the highest quartile). There appears to be no substantial variation in the distribution of patents across public and private firms between countries with weak and strong minority shareholders protection laws. This is again surprising in light of the strong correlation between financial development and minority shareholders protection laws.

To understand better what may be driving these results, we turn to a more detailed comparison of organizational forms across countries.

Insert Table 4 here

Business groups vs. Conglomerates In comparing business groups to conglomerates we consider two factors: anti-group laws, and the strength of minority shareholder protection. Anti-group laws and weak minority shareholder protection make business groups less attractive. Anti-group laws are strong in the U.S., but hardly exist in Europe. Thus, other things equal, we expect more innovation to be concentrated in business groups in Europe than in the U.S. Only 1.5% of U.S. and U.K. patents are held by partly-owned affiliates, while in continental Europe 11.2% of the patents are held by partly-owned affiliates. This percentage varies significantly across countries, reaching a high of 25% in France. This pattern is consistent with the theory. Computing the ratio between patents held by partly-owned affiliates and conglomerates, leads to

the demand for external capital is higher, especially in countries with less developed financial institutions. Thus, their econometric approach is to examine whether the difference in the percentage of group affiliates between industries with high and low external dependence becomes more pronounces as the country financial development deteriorates. The evidence suggests that business-groups indeed substitute missing financial institutions.

a similar conclusion. In France 11.550 patents are held by affiliates with minority shareholders, and 20.676 patents are held by conglomerates[22]. The ratio between the number of partly-owned affiliate and conglomerate patents for France is 0.56 (11.550/20.676), for Italy 0.62 (2.320/3.763), for Germany 0.08[23] (10.949/135.220), for Great Britain 0.02 (631/30.809), and for the U.S. 0.02 (3.417/198.006). These figures imply that relative to conglomerates, partly-owned affiliates are more prevalent in France and Italy than in the U.S., Great Britain, and Germany.

There is substantial variation in the anti-directive index across countries. For France, the anti-directive index is 3, as compared to 1 for Germany. Our theoretical analysis predicts a higher share of innovation in business groups in France than in Germany. The findings support this prediction (a ratio of 0.56 for France versus a ratio of 0.08 for Germany). Yet, when we compare Great Britain to Germany, the opposite ranking emerges: in Britain only 631 patents are held by partly-owned affiliates, as compared to about 30.809 patents by conglomerates. Indeed, minority shareholders in affiliates are very rare in Britain, which is a puzzle given that Britain has unusually strong minority shareholder protections.

Standalones vs. conglomerates Standalones should be more prevalent than conglomerates in countries with more developed financial markets (R&D capitalization value is higher). To examine the prevalence of standalones relative to conglomerates we compute the ratio of the number of patents held by standalones and the number of patents held by conglomerates. Our findings are mixed. In the U.S., 23.970 patents are held by standalones, and 198.006 patents are held by conglomerates. The standalones-conglomerates ratio, thus, is 0.12. For Great Britain, France and Germany, the ratio is 0.17, 0.11, and 0.20, respectively. Compared to the U.S., standalones are relatively more prevalent than conglomerates in Great Britain and Germany,

[22] For business-groups, we focus only on affiliates with minority shareholders, because anti-group and minority-shareholder protection laws typically do not apply to wholly-owned affiliates. When including also wholly-owned affiliates, 50% of the French patents are held by business-groups.

[23] The top four German conglomerates hold 94.180 patents in the EPO. Excluding these companies raises the ratio between business group and conglomerate patents to 0.27.

and have a similar prevalence in France. For smaller countries in our sample, the ranking is also unclear: Switzerland has a very high market capitalization, especially as compared to the Netherlands. The standalones-conglomerates ratio in Switzerland, is 0.16, and in the Netherlands it is 0.03. This ranking is consistent with our theoretical analysis, but when we compare the Netherlands to France or Germany, which by our measure have lower stock-market capitalizations, the findings become inconsistent with our theory.

Business groups vs. Standalones Standalones are likely to represent a bigger share of R&D than business-groups in countries where anti-group laws are strong and minority-shareholder protection is weak. As the U.S. has both more restrictive anti-group laws and stronger minority-shareholder protections than European countries, it is not entirely clear how the U.S. would compare with Europe in terms of the relative shares of R&D in standalones and business groups. However, as the tax costs of running a business-group are so high in the U.S. relative to Europe, we expect innovating standalones to be more prevalent in the U.S. than in Europe. Our evidence supports this prediction. The ratio between the number of patents held by partly-owned business group affiliates and standalones in the U.S. is 0.14, and is 0.19 in Europe. This ratio varies considerably across European countries: in Great Britain the affiliates-standalones ratio is 0.12, in Germany is 0.41, and in France is 5.07.

As for the effects of minority-shareholder protections, our evidence is again mixed. While the Germany-France comparison is consistent with our analysis, as minority-shareholder protections are higher in France (at least as reflected by the anti-directive index), the comparison with Great Britain is not. The ratio between business group and standalone patents in Great Britain is much lower than in Germany and France, again despite the fact that minority-shareholder protections in Great Britain are substantially higher.

What could explain these mixed results on organizational form and country conditions? There are three possibilities: (i) country conditions may be endogenously affected by ownership structure; (ii) unobserved and observed country heterogeneity make it hard to obtain a clean identification, and; (iii) different industry specialization across countries may affect the aggregate distribution of organizational forms. To examine in greater depth the choice of organizational form across industries, we turn next to an analysis of organizational variation across industries.

5.1.2. Comparing across industries

In industries with rapid, incremental, innovations the ability of conglomerate firms to quickly identify the relevant innovations and to quickly redeploy assets may give it an edge over business groups. In contrast, in industries with a slower and more fundamental innovation cycle, the intellectual protection of the innovator may be of greater importance, giving business groups an edge over conglomerates. To explore these predictions, we look at four different industries: pharmaceuticals and biotechnology as examples of industries with a long innovation cycle, and computer hardware and telecommunications as examples of industries with rapid and incremental innovations. Table 5 summarizes the main findings for EPO patents.

Business groups vs. Conglomerates By our theoretical analysis, innovation ought to be more prevalent in a partly-owned business group affiliates than in a conglomerate division in the pharmaceuticals and biotechnology industries, but not in the computer hardware and telecommunications sectors. Our findings confirm this prediction. In pharmaceuticals and biotechnology the ratio between the number of business group patents and conglomerate patents is 0.07, and 0.21, respectively[24], where in computer hardware and telecommunications the respective ratios are substantially lower at 0.02 and 0.03.[25]

Another interesting ranking emerges when comparing the U.S. to Europe. In the U.S., the patent ratio of business-group-to-conglomerate patents for both pharmaceuticals and biotech-

[24] When including patents by wholly-owned business group affiliates, the pharmaceuticals and biotechnology ratios are 0.13 and 0.28.

[25] When including patents by wholly-owned business group affiliates, the computer hardware and telecommunications ratios are 0.06 (354/5.876) and 0.11 (3.667/34.286). It is interesting to note that the majority of business group patents are held by wholly-owned affiliates, especially in telecommunications, and not in partly-owned affiliates, as in pharmaceuticals and biotechnology.

nology is 0.01. In Europe, on the other hand, these figures are much higher at 0.11 and 0.35, respectively. The prevalence of business groups in pharmaceuticals and biotechnology is, thus, strongly driven by European firms. For computer hardware and telecommunications the respective ratios are very small in both the U.S. and Europe, indicating that innovation activity in partly-owned affiliates is very small.

Standalones vs. Conglomerates Standalones resemble partly-owned affiliates in terms of their governance structure, and thus should have the same relative advantages over conglomerates in pharmaceuticals and biotechnology, but less so in computer hardware and telecommunications. Thus, the relative prevalence of standalones should be similar to that of partly-owned affiliates. Our findings support this prediction. In pharmaceuticals and biotechnology the ratios between standalone and conglomerate patents are 0.20 and 0.32, respectively, where in computer hardware and telecommunications these ratios are substantially lower at 0.11 and 0.07. Again, in industries where high-powered incentives are of greater importance, partly-owned affiliates are more prevalent. Standalones seem to be more prevalent in the U.S. than in Europe, especially in biotechnology. This finding is consistent with our theory, which predicts a higher prevalence of standalones in countries where R&D capitalization value is higher, especially in industries where the governance benefits of standalones are more pronounced.

Business groups vs. Standalones Partly-owned affiliates and standalones have a similar governance structure. However, partly-owned affiliates can benefit from the business-group internal capital market. On the other hand, standalones face smaller diversion costs than a business-group affiliate. These considerations imply that we would expect partly-owned affiliates to be more prevalent than standalones in industries where winner-picking is more important, especially in countries that do not have anti-group laws, and where minority protection is strong. Our findings, however, do not support this prediction: business-groups are more prevalent as compared to standalones in pharmaceuticals and biotechnology, than in computer hardware and telecommunications[26]. A potential explanation is related to fund raising. Standalones, especially those that operate in countries with less developed financial markets, may find it easier to finance projects that have a shorter development cycle. In this respect, business-groups may be able to provide more stable financing for longer term and riskier research projects.

Insert Table 5 here

5.2. Patent quality

So far our analysis focused on the number of patents. However, it is well recognized that the distribution of patent quality is highly skewed, where a small portion of patents receive many citations, and the majority of patents receive only few or no citations at all. Using the number of citations a patent receives as our main quality indicator, table 6 compares the quality of conglomerate and partly-owned affiliate patents (for brevity, we do not discuss the respective comparison for patents by standalones). We control for cohort and technology area effects using the weighting scheme proposed by Trajtenberg (1990). For each patent, we divide the number of citations it receives by the average number of citations received by all patents granted at the same year and classified under the same three-digit technology code.

Panel A reports the comparison analysis for U.S. and Great Britain patents. Conglomerate patents seem to be of higher quality than business group patents: the average conglomerate patent receives 1.23 (weighted) citations, as compared to a business group patent that receives on average 1.12 citations (the difference in means is significant at the 1% level). We also examine the case of self-citations; where an inventor cites one of its predecessor patents. Self-citations are commonly regarded as measures of cumulative innovation, and are typically associated with greater private value (Hall et al., 2005). Conglomerate patents receive significantly more self-citations than business group patents (1.57 versus 0.98). Additional indicators of patent

[26] The ratios between partly-owned affiliate and standalone patents are 0.37 and 0.66 in pharmaceuticals and biotechnology, and 0.24 and 0.42 in computer hardware and telecommunications, respectively.

importance are *generality* and *originality*. These indicators measure the extent the knowledge embodied in a patent 'spills-over' to more technology areas (*generality*), or builds on knowledge from many different technology fields (*originality*).[27] With respect to patent generality and originality, conglomerates also seem to dominate. The average generality (originality) value for a conglomerate patent is 0.278 (0.274), as compared to 0.266 (0.264) for a business group patent (the difference in means is significant at the 1% level).

We conduct the same comparison for continental European countries (panel B). Interestingly, the opposite pattern of results emerges. Business group patents tend to be of higher quality and concern more *basic* research than conglomerate patents. The average conglomerate patent receives 0.71 citations, as compared to a business group patent that receives on average 0.88 citations (the difference in means is significant at the 1% level). Business group patents are also more general and original: the average generality (originality) value for a conglomerate patent is 0.231 (0.226), as compared to 0.264 (0.239) for a business group patent (the difference is significant at the 1% level).

Insert Table 6 here

5.3. *Coasian* or *Entrenched* organizational forms?

A basic premise of our analysis is a *Coasian perspective* on firm organization, which is to say that R&D intensive firms tend to choose the corporate form that is best suited for fostering innovative activities. Thus, we expect a corporate form that is particularly well suited for

[27] We follow Trajtenberg et. al. (1997), and compute patent generality as the Herfindahl-Hirschman Index of the concentration of the citations a patent receives across three-digit technology fields. The generality index for patent i, dented by G_i, is:

$$G_i = 1 - \sum_j \left(\frac{CR_{ij}}{CR_i} \right)^2$$

Where, j denotes three-digit technology fields, CR_{ij} is the number of citations received by patent i from patents in technology field j, and CR_i is the total number of citations received by patent i. For patent originality, we use the same formulation, but for the distribution of the number of citations the patent makes across technology fields.

innovative firms to be more prevalent among these firms in a given industry than among non-innovating firms. The alternative view in the literature is that organization form is chosen by entrenched managers, or controlling shareholders, to suit their best interests at the expense of minority shareholders and overall firm efficiency. By this latter view it is not obvious that one should see any systematic difference in organization form in a given industry across innovative and non-innovative firms. In this section we explore the extent to which organization form differs between innovative and non-innovative firms. Essentially, we examine whether innovative firms are disproportionately represented in a given organization category, using aggregated sales in the same category as a benchmark. We say that patents are disproportionately represented in one category over another, if the patent ratio of the two categories is higher than the sale ratio of the same categories. For this comparison our sample includes close to 3.5 million firms with sales information.

Table 7 summarizes the main findings. First, patents are disproportionately concentrated in partly-owned affiliates relative to standalones, with patent and sales ratios of 0.57 and 0.33, respectively. This pattern is driven mostly by firms in continental Europe, where the patent and sale ratios are 0.84 and 0.56. In the U.S. and Great Britain, on the other hand, these ratios are virtually identical at 0.14 and 0.12. Second, patents are disproportionately concentrated in conglomerates relative to partly-owned affiliates (patent and sale ratios of 0.09 and 0.17). This pattern is much stronger in continental Europe, where the patent and sale ratios are 0.17 and 0.42, respectively. In the U.S., these ratios are identical at 0.02. Third, organization form varies substantially across industries. As in the previous section, we focus on pharmaceuticals and biotechnology (panel B)[28], and telecommunications (panel C). Consistent with the *Coasian perspective*, in pharmaceuticals and biotechnology, innovation is disproportionately concentrated in partly-owned affiliates relative to conglomerates (patent

[28]We combine pharmaceuticals and biotechnology because many companies that operate in pharmaceuticals also operate biotechnology. Unlike patents, where we can classify each patent to a technology field according to its IPC code, it is much more difficult to breakdown sales by industries, especially in conglomerates that usually report consolidated accounts.

and sale ratios of 0.11 and 0.06). Yet again, this pattern is driven by European firms. In the U.S. alone, the patent and sale ratios are identical (0.01), while in Europe the patents ratio is substantially higher than the sales ratio (0.18 versus 0.13). In telecommunications (panel C), on the other hand, business-group patents are under-represented relative to sales in Europe (patent and sale ratios of 0.04 and 0.08, respectively), and in the U.S., the patent and sale ratios are effectively zero. Finding disproportionately more conglomerate patents in telecommunications is also consistent with the *Coasian perspective*, as we expect that in this industry conglomerates are more conductive to R&D than business-groups.

Insert Table 7 here

5.4. Robustness

We conduct several robustness tests to check the sensitivity of our findings, focusing mostly on the ownership algorithm, and organization form definitions. To ensure ownership shares represent control, we keep only links where the shareholder has at least 50% of the voting rights for private firms, and 20% of the voting rights for public firms. We check the sensitivity of our results by experimenting with different control thresholds. The same pattern of results continue to hold for thresholds of 40% and 25% for private firms, and 10% for public firms. Furthermore, we construct business group structures using the algorithm developed by Almeida, Yong Park, Subrahmanyam, and Wolfenzon, 2007 (AYPSW). Due to computational power constraints we are not able to run their algorithm on our full set of firms. While restricting the ownership sample is problematic, the general pattern that emerges highly resembles the one generated by our own algorithm. The advantage of AYPSW over our algorithm is that it better deals with cases of cross-holdings (for example, firm A control 50% of the voting rights of firm B, and firm B controls 50% of the voting rights of firm A).[29] However, while cross-holdings are prevalent in East-Asian countries, where the AYPSW algorithm was first implemented, we find

[29] The main advantage of our algorithm over AYPSW is that it is better designed to efficiently handle large datasets on ownership ties.

that cross-holdings are very rare in Europe. Actually, only 0.01% of the ownership chains our algorithm generates are associated with some form of cross-holdings.

We distinguish between standalones and conglomerates by determining whether a firm is specialized or diversified. We assume a firm is diversified if it operates in at least two different two-digit industry SIC. The same pattern of results continue to hold when we define diversification at the one-digit SIC level. Moreover, we supplement the industry information with data on the firm patenting distribution across technology fields. We check whether diversified firms also tend to patent in more than one technology areas. We find that about 80% of the conglomerates in our sample patent in more than one two-digit IPC fields. The general pattern of results continue to hold when we use the IPC fields in defining conglomerates.

We also distinguish between patents that were acquired by a business group and patents that were generated internally. We use Zephyr to track changes in ownership structure through M&As (table A1). We find that, on average, 9% of the firms joined a business group between 1997 and 2007, where the remaining 91% are associated with an organic business group expansion. Our main findings continue to hold also when excluding patents that were acquired through M&A.

6. Conclusion

This paper examines the relation between organization form and innovation for a cross-section of private and publicly traded innovating firms in the U.S. and 15 European countries. Several new findings emerge from our analysis. First, while most innovating firms in the U.S. are publicly traded conglomerates, a substantial fraction of innovation is concentrated in private firms and in business groups in continental European countries. Second, there is a substantial variation in organization form across industries. Business groups tend to be concentrated in industries where innovation takes time, is highly uncertain, and where the intellectual protection of the innovator may be of paramount importance. On the other hand, conglomerates are more prevalent in industries with rapid, incremental, innovation where the ability of conglomerates to promptly identify the relevant innovation and to quickly redeploy assets may give it an edge over business groups. Third, our findings are consistent with a *Coasian view* of how firms organize themselves: namely that R&D intensive firms tend to choose the corporate form most conducive to innovation. This is especially true in Europe, where there are fewer regulatory hurdles to the formation of business groups and hybrid corporate forms. It is not the case in the U.S., where tax and regulatory hurdles essentially eliminate any gains from forming business groups, and where a highly visible VC and private equity sector provides an alternative to business-group financing of R&D.

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A. Appendix

A.1. Constructing ownership structure

This section details the construction and output of our newly developed algorithm. The purpose of the algorithm is to determine the structure of European business-groups based on the Amadeus ownership database. The algorithm consists of two parts: a control-chain generator that constructs the ownership and control links between different European firms, and a name matching procedure that groups together firms controlled by the same ultimate owner. Our source of information is the ownership sections of the 2008 versions of Amadeus (for the European subsidiaries) and Icarus (for the American subsidiaries).

A.1.1. The Control chain generator

The Amadeus ownership database includes detailed information on the percentage of ownership between European corporate shareholders and their European subsidiaries. The data span virtually all European countries (including Eastern Europe). Icarus provides similar information for the United States. We develop an ownership algorithm that constructs the internal structure of business-groups based on these inter-company ownership links. The main benefits of the algorithm are: (i) it constructs the ownership chains without relying on the (often missing) information on whether an ownership link is direct or indirect,[30] (ii) it completes missing ownership links by transitivity, (iii) it identifies cross-holdings, and (iv) it handles complex ownership structures. These features allow us to develop robust measures of business-group characteristics (such as group size).

We include all ownership links from the Amadeus ownership database that represent a control relation. For this, we make the following assumptions: for private subsidiaries, a shareholder exerts control if its direct percentage of ownership is larger than 50. For public firms, the percentage of direct ownership has to be larger than 20 to represent a control relation (since ownership is typically less concentrated in public firms than in private firms).[31]

There are about 1 million direct ownership links that satisfy our control assumptions, where 291.974 shareholders control 789.557 subsidiaries. The average percentage of direct ownership is 91 with a median of 100 (59 percent of the ownership links represent a wholly-owned relation). There are 1.369 public subsidiaries. For these public subsidiaries, the average percentage of direct ownership is 53 with a median of 48. The input file of direct ownership links generates 718.092 ownership chains. 69 percent of the chains include only two firms (13 percent of the chains include more than 3 firms and 3 percent of the chains include more than 5 firms). 63 percent of the chains are wholly-owned (for all levels in the chain). For chains where the apex in an American or British firms, 83 percent are wholly-owned, for German apex firms, 60 percent of the chains are wholly-owned, where for French apex firms, only 25 percent are wholly-owned.

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[30] Indirect ownership links are very common in our data. Suppose, for example, that firm A owns 60% of the shares of B and that B owns 60% of the shares of C. In this case, firm A has a *direct ownership* of 60% in B and an *indirect ownership* of 36% in C.

[31] Similar assumption was made by La Porta et al. (1999) and Faccio and Lang (2002).

A.1.2. Description of the algorithm

The algorithm follows three steps: (i) completes missing ownership links, (ii) generates lists of all subsidiaries and parents for each company, and (iii) constructs the ownership chains bottom-up.[32] To illustrate our methodology, it would be useful to consider the following example. Suppose Figure A.1 correctly describes the ownership structure of a business-group. The ultimate owner (for example, a family) at the apex of the group controls 7 public and private firms. Amadeus provides detailed data on direct ownership links. Thus, our raw data include the links $A \to D$, $B \to F$, $C \to G$, and $D \to E$. Note that the percentage of ownership for the link $C \to G$ has to be larger than 20 (because firm G is public), where for the percentage of ownership for all other links has to be larger than 50 (because the other subsidiaries are private). Because there is no information about indirect ownership links, the link $A \to E$ is missing from the raw data. The first step of the algorithm is to complete missing links. As we observe the ownership relations $A \to D$ and $D \to E$, our algorithm infers the ownership relation $A \to E$. Note that at this stage of the algorithm we still do not know whether the ownership relation is direct or indirect (and if it is indirect, how many layers separate firm E from firm A). The second step of the algorithm is to construct two lists for each firm: shareholders and subsidiaries. This step saves valuable running time, which is especially important when dealing with large scale ownership data. The following table is generated:

Firm	Shareholder	Subsidiary
A	-	D, E
B	-	F
C	-	G
D	A	E
E	A, D	-
F	B	-
G	C	-

Note that from step 1, we already know that firm A is a shareholder of firm E. Also, because we assume the ultimate owner is a family, firms A, B, and C have no corporate (European) shareholder. The third and final step of the algorithm is to construct the structure of the group based on the above ownership relations. Because of the missing links problem, our algorithm does not assume that an ownership relation is direct; the only input the algorithm receives is the existence of the ownership relation. We start with a firm that has no subsidiaries from the list generated in step 2. We illustrate the procedure for firm E, which is the most interesting in this example. Firm E is placed at the bottom of the ownership chain. Next, we move to the shareholder list of firm E. It includes firms A and D. Starting arbitrary with A, place A above E. Proceeding to firm D, there are three possibilities for its location: (i) D is above E and above A; (ii) D is above E, but below A; (iii) D is above E, but not below neither above A (different ownership chain). For (i) to be the right structure, D has to appear in the shareholder list of firm A. From step 2, we rule this out. For (ii) to be the right structure, D has to appear on the subsidiary list of firm A. From step 2, this holds. Finally, for (iii) to

[32] Unlike business groups in East Asia (such as the Japanese keiretsu), most European business groups are organized in pyramids (Figure A.1). This means that interlocking shareholdings are not common and, therefore, ownership chains can be constructed bottom-up.

be the right structure, A cannot appear on either the shareholder or subsidiary lists of firm D. From step 2, this is ruled out. At the end of this procedure, we have determined for each ownership chain the highest shareholder firm - we call this firm the leading shareholder.

Our algorithm fails in the case of cross-holdings. A cross-holding is an ownership structure where a shareholder is also a subsidiary of its own subsidiary. For example, suppose we also observe the ownership link $E \rightarrow A$. Our ordering procedure will not work because there is no starting point: no firm is placed at the bottom of the business-group and, therefore, the leading shareholder cannot be determined.[33] Yet, we observe only few cases of cross-holdings in the data (0.5 percent of the ownership links are associated with at least one cross-holding).

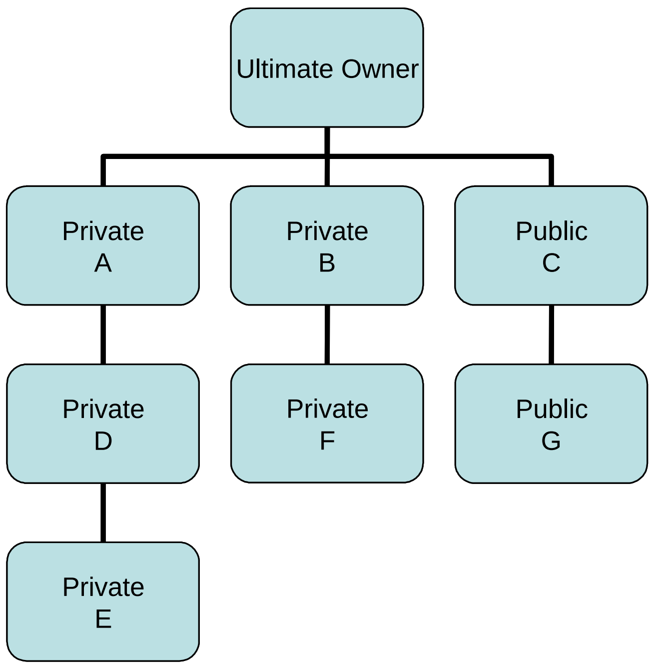


Figure A.1: Example of a business-group

A.1.3. Ultimate owner name matching

The next part of our algorithm groups firms across ownership chains based on the name of the ultimate owners. The name matching process deals with two main issues. First, ultimate owner names are not standardized, i.e., the same name can be spelled differently across subsidiaries. Second, common names, especially for family members, may lead to 'over-grouping'. We deal with theses issues as following. First, we develop a name standardization procedure that harmonizes the different string patterns in our data. Second, to ensure families are indeed wealthy, we search for publicly available information, such as Forbes and The Economist, on the largest 500 wealthiest families in our sample (for example, De Rotchild family, Nasi-Agnelli family). For the other individual ultimate owners in our sample, we compute the frequency of the appearance of the name in the ultimate owner population. In case this frequency is higher

[33] A less 'severe' case of cross-holding is where we observe $E \rightarrow D$. In this case, our algorithm constructs two ownership chains: $A \rightarrow D \rightarrow E$ and $A \rightarrow D \rightarrow E$, where both correctly characterize the ownership structure. The leading shareholder is firm A in both cases, which allows us to correctly group firms into business groups.

than the median frequency, we assume the common name problem and do not include that ultimate owner in our sample. Our control assumptions may lead to cases where we miss-classify firms to groups. For example, suppose an ultimate owner controls 33 percent of firm C, and firms A and B control each 33 percent of firm C. Assuming firm C is private, our algorithm will not assign firm C to a group. The ultimate owner fully controls firm C (via its control of firms A and B), thus firm C should be part of the group. To deal with this situation we take the following step. For firms that were not assigned to groups we extract a list of their immediate shareholders (corporate and individuals). For each shareholder we already know whether it belongs to a group and its ultimate owner (as indicated by the ownership algorithm). Then, we examine whether an ultimate owner controls more than 50 percent of the stocks for private firms and more than 20 percent of the stocks for public firms. In case the aggregated holding of the ultimate owner meets these threshold, we assign the affiliate to the group.

A.2. Matching patent data

A.2.1. European Patent Office (EPO)

The matching between EPO patent applicants and Amadeus firms has been a collaborative project with the Institute for Fiscal Studies (IFS) and the Centre for Economic Performance (CEP). This section is a brief summary of the matching procedure.

Our main information source on patents is the 2007 publication of the PATSTAT database, which is the standard source for European patent data. This database contains all bibliographic data (including citations) on all European patent applications and granted patents, from the beginning of the EPO system in 1979 to the end of 2007.

We match the name of each EPO applicant listed on the patent document to the full name of a firm listed in Amadeus (about 8 million names). Since we are interested only in matching patent applicants to firms, we exclude applicant names that fall into the following categories: government agencies, universities, and individuals. We identify government agencies and universities by searching for a set of identifying strings in their name. We identify individuals as patents where the assignee and the inventor name strings are identical.

The matching procedure follows two main steps. (i) Standardizing names of patent applicants. This involves replacing commonly used strings which symbolize the same thing, for example "Ltd." and "Limited" in the UK. We remove spaces between characters and transform all letters to capital letters. As an example, the name "British Nuclear Fuels Public Limited Company" becomes "BRITISHNUCLEARFUELSPLC". (ii) Name matching: match the standard names of the patent applicants with Amadeus firms. If there is no match, then try to match to the old firm name available in Amadeus. We need to confront a number of issues. First, in any given year, the Amadeus database excludes the names of firms that have not filed financial reports for four consecutive years (e.g. M&A, default). We deal with this issue in several ways. First, we use information from historical versions of the Amadeus database (1995-2006) on names and name changes. Second, even though Amadeus contains a unique firm identifier (BVD ID number), there are cases in which firms with identical names have different BVD numbers. In these cases, we use other variables for identification, for example: address (ZIP code), Date of incorporation (whether consistent with the patent application date), and more. Finally, we manually match most of the remaining corporate patents to the list of Amadeus firms.

Some groups assign many of their patents to a single subsidiary. This subsidiary typically does not innovate and its main purpose is to manage the intellectual property assets of the group. We identify such firms using their SIC classification. We use information on the location of the patent inventors to match the centrally-assigned patents to innovative affiliates. The secondary assignment of these patents is based on a match between the address of the patent inventor and the group affiliates. In case the address of the inventor matches multiple group affiliates we make the following assumption: if only one of the affiliates innovates (as indicated by the number of patents this affiliate already has), assign the patent to this innovative affiliate. If more than one of the matched affiliates innovates, keep the original central assignment of the patent. The secondary matching procedure increases the number of innovative affiliates by about 250 firms.

A.2.2. United States Patents and Trademarks Office (USPTO)

The procedure described above matches European firms to patents registered with the EPO. Yet, some European firms register patents only with the USPTO, without applying to the EPO. In order to identify the European firms that only apply to the USPTO, we match the complete set of Amadeus firms to the name of the patent applicants from the USPTO. The most updated patent database for the USPTO is the 2002 version of the NBER patents and citations data archive. Because this database covers patent information only up to 2002 and our accounting data go up to 2007, we updated the patent data file by extracting all information about patents granted between 2002 and 2007 directly from the USPTO website.[34] Having updated the USPTO patent database, we follow the matching procedure described above to create the matched USPTO patent data for the Amadeus firms.

A.3. Matching scientific publications

The largest database on scientific publications is the ISI Web of Knowledge (WoK) by Thomson. This includes millions of records on publications in academic journals. The data is divided to three main categories based on the publication type: hard sciences, social sciences, and arts and humanities. Because we are interested in capturing investment in scientific research, we focus only on the hard sciences section of WoK. This section includes publication records over the period 1970-2007. The address field on each record indicates the affiliation of the authors of the publication. This affiliation is typically either a research institution or a firm. We use the name appearing in this field and match it to the complete list of Amadeus firms. We follow the same matching procedure as described above for the EPO and USPTO patent matching. Articles may have more than one author (the median number of authors per article is 2). In this case, the address field would include multiple affiliations. We assign a scientific publication to a specific firm if the name of this firm appears at least once in the address field of the article. This procedure means that a single article can be assigned to more than one firm, but a firm cannot be assigned more than once to the same article. For each article, we also extract information on the number of times it was cited, the journal in which it was published, and the year of publication. Information about the importance of journals is taken from the Journal Citations Report index (JCR). Finally, European research institutions can be incorporated, thus, they appear in Amadeus as potential firms to be matched. To screen out such firms,

[34] http://patft.uspto.gov/netahtml/PTO/srchnum.htm

we follow two steps. First, as for patent matching, we drop Amadeus names that include strings that are associated with research institutions (such as, UNIVERSITY, RESEARCH, INSTITUTION, etc.). Second, we manually examine the websites of firms that have a large number of publications but appear as small firms in terms of their sales and number of patents. For these firms, we check whether their primary activity is research. In case the primary activity is research, we exclude them from our matched sample.

A.4. Industry patent classification

Table 7 summarizes the distribution of patents across selected industries. The classification of patents to these industries is based on the patent International Patent Classification, as following. Pharmaceuticals includes IPCs A61 (excluding A61B, A61K 38, A61K 39, and A61K 48). Biotechnology includes IPCs A01H 1/00, A01H 4/00, A61K 38/00, A61K 39/00, A61K 48/00, C02F 3/34, C07G 11/00, C07G 13/00, C07G 15/00, C07K 4/00, C07K 14/00, C07K 16/00, C07K 17/00, C07K 19/00, C12M, C12N, C12P, C12Q, C12S, G01N 27/327, G01N 33/53, G01N 33/54, G01N 33/55, G01N 33/57, G01N 33/68, G01N 33/74, G01N 33/76, G01N 33/78, G01N 33/88, and G01N 33/92. Computer Hardware includes G06F 13/12, G11C, G065 15, and H01L. Telecommunications includes H04B, H04L, H04N, H04M, H04K, H04J, and H04H.

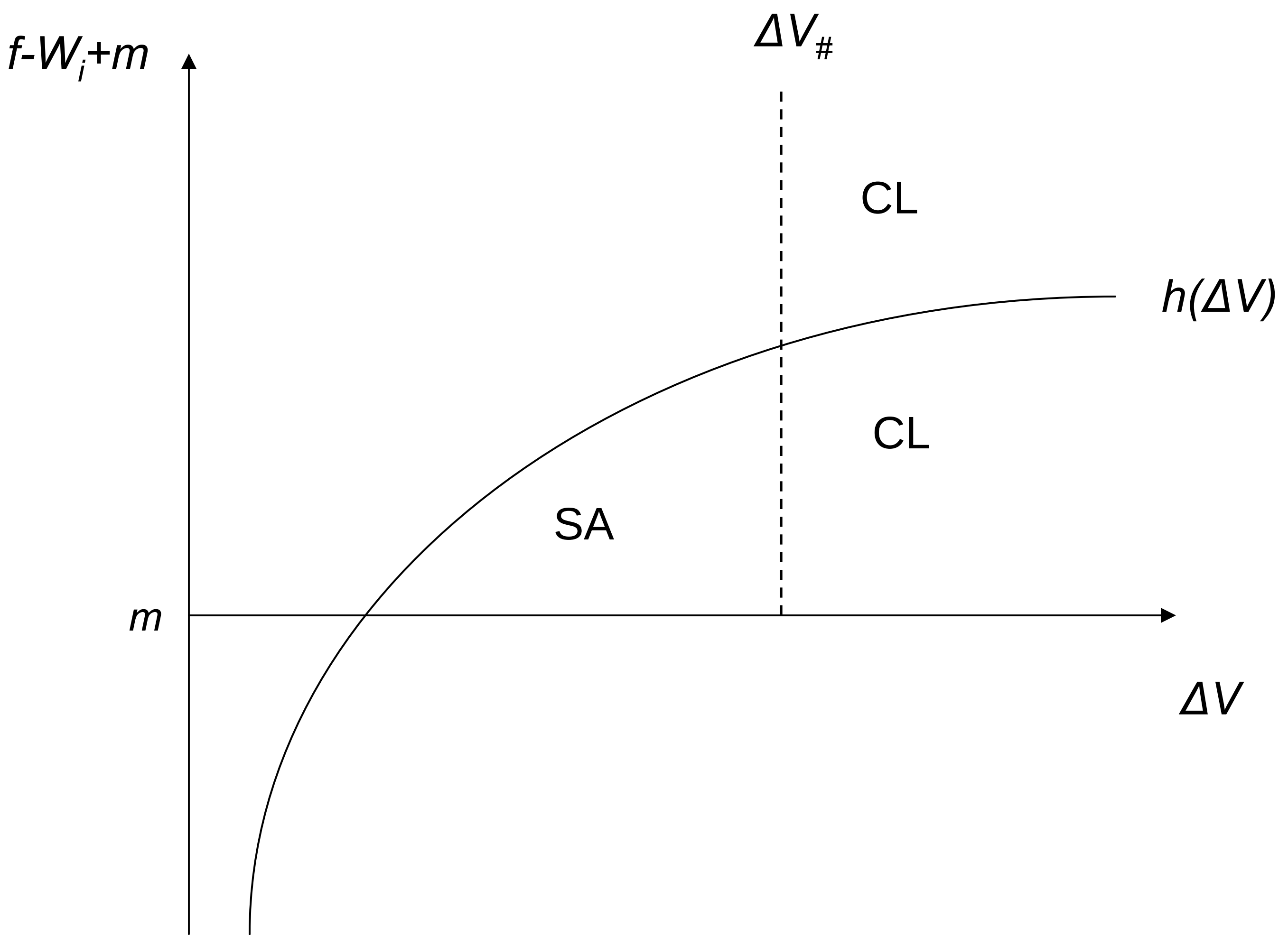


Figure 1

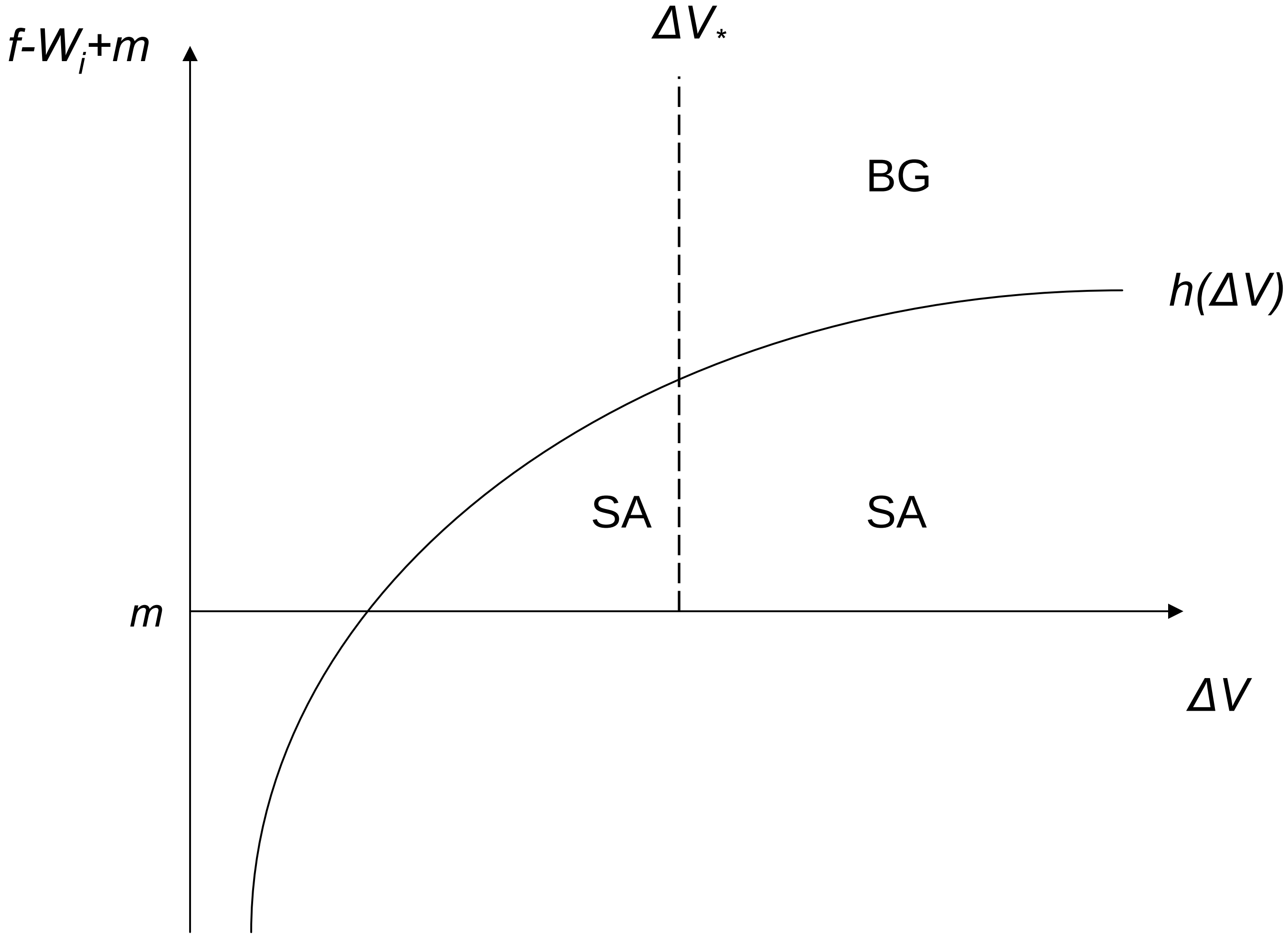


Figure 2

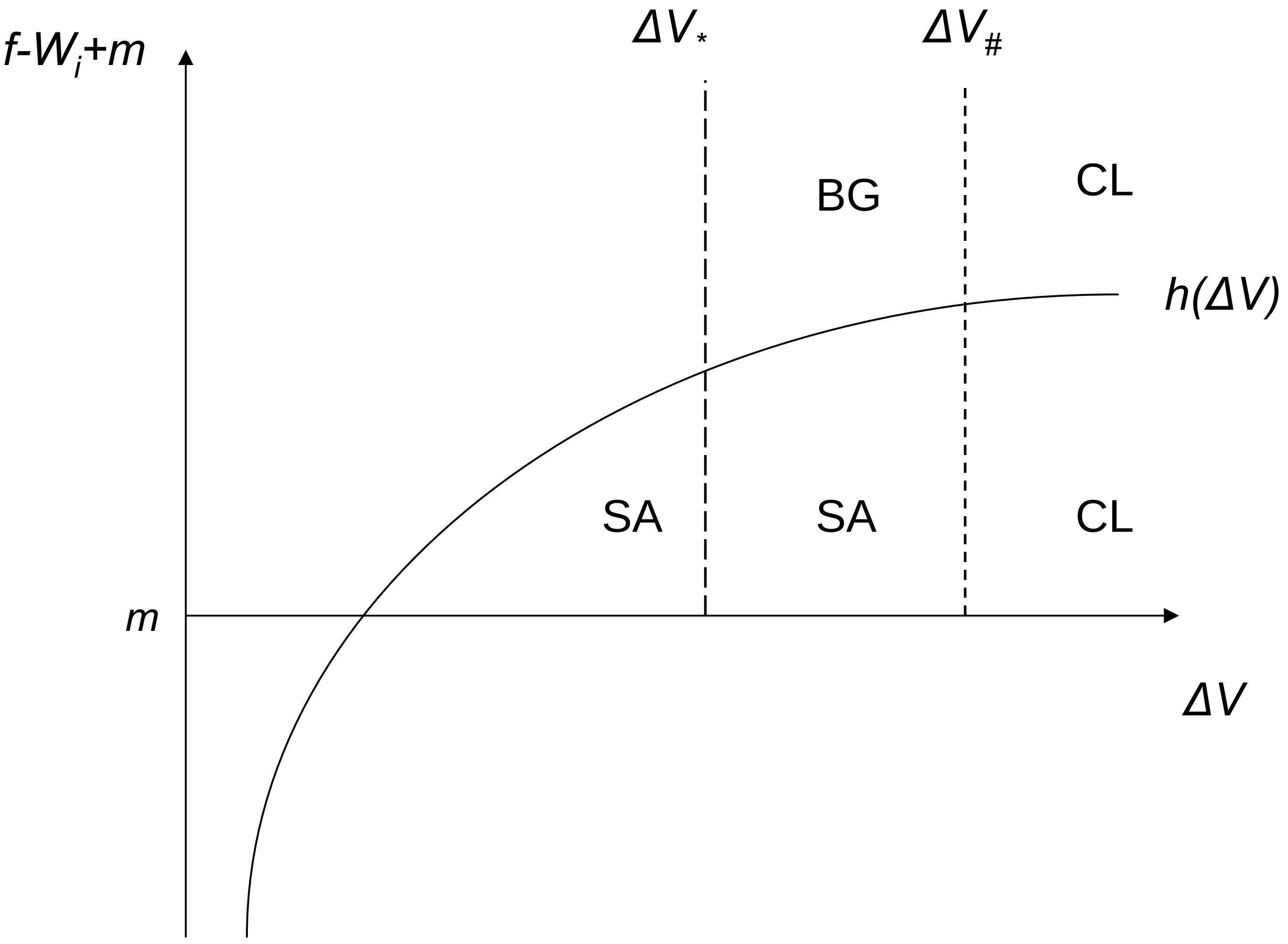


Figure 3

TABLE 1:

INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES

PANEL A. NUMBER OF FIRMS

Ultimate Owner Country	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*	
Austria	382	234	174	120	54	790
	(48%)	(30%)	(22%)	(15%)	(7%)	
Belgium	363	141	240	156	84	744
	(49%)	(19%)	(32%)	(21%)	(11%)	
Denmark	177	151	138	81	57	466
	(38%)	(32%)	(30%)	(17%)	(12%)	
Finland	575	238	103	67	36	916
	(63%)	(26%)	(11%)	(7%)	(4%)	
France	884	518	962	480	482	2,364
	(37%)	(22%)	(41%)	(20%)	(20%)	
Germany	3,942	2,044	842	468	374	6,828
	(58%)	(30%)	(12%)	(7%)	(5%)	
Great Britain	2,466	1,842	672	569	103	4,980
	(50%)	(37%)	(13%)	(11%)	(2%)	
Greece	24	4	4	1	3	32
	(75%)	(13%)	(13%)	(3%)	(9%)	
Italy	2,073	699	347	139	208	3,119
	(66%)	(22%)	(11%)	(4%)	(7%)	
Netherlands	161	230	252	189	63	643
	(25%)	(36%)	(39%)	(29%)	(10%)	
Norway	349	90	88	51	37	527
	(66%)	(17%)	(17%)	(10%)	(7%)	
Republic of Ireland	40	20	29	25	4	89
	(45%)	(22%)	(33%)	(28%)	(4%)	
Spain	396	197	113	40	73	706
	(56%)	(28%)	(16%)	(6%)	(10%)	
Sweden	380	328	376	246	130	1,084
	(35%)	(30%)	(35%)	(23%)	(12%)	
Switzerland	634	582	236	165	71	1,452
	(44%)	(40%)	(16%)	(11%)	(5%)	
Total Europe	*12,846*	*7,318*	*4,576*	*2,797*	*1,779*	*24,740*
	(52%)	*(30%)*	(18%)	(11%)	*(7%)*	
United States	30,187	7,810	1,295	1,127	168	39,292
	(77%)	(20%)	(3%)	(3%)	(0%)	
Total	43,033	15,128	5,871	3,924	1,947	64,032
	(67%)	(24%)	(9%)	(6%)	(3%)	

TABLE 1: *(Cont'd)*

INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES

PANEL B. NUMBER OF USPTO PATENTS

Ultimate Owner Country	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*	
Austria	684 (28%)	994 (41%)	763 (31%)	381 (16%)	382 (16%)	2,441
Belgium	309 (7%)	1,736 (37%)	2,600 (56%)	740 (16%)	1,860 (40%)	4,645
Denmark	289 (8%)	2,338 (63%)	1,106 (30%)	477 (13%)	629 (17%)	3,733
Finland	651 (12%)	4,595 (82%)	327 (6%)	279 (5%)	48 (1%)	5,573
France	801 (3%)	9,487 (35%)	17,077 (62%)	11,832 (43%)	5,245 (19%)	27,365
Germany	12,052 (11%)	86,564 (80%)	9,407 (9%)	3,388 (3%)	6,019 (6%)	108,023
Great Britain	4,775 (15%)	22,581 (73%)	3,752 (12%)	3,596 (12%)	156 (1%)	31,108
Greece	17 (81%)	0 (0%)	4 (19%)	1 (5%)	3 (14%)	21
Italy	3,246 (56%)	1,295 (22%)	1,222 (21%)	369 (6%)	853 (15%)	5,763
Netherlands	242 (3%)	8,219 (89%)	738 (8%)	516 (6%)	222 (2%)	9,199
Norway	393 (58%)	131 (19%)	148 (22%)	121 (18%)	27 (4%)	672
Republic of Ireland	61 (24%)	50 (20%)	138 (55%)	131 (53%)	7 (3%)	249
Spain	369 (52%)	127 (18%)	209 (30%)	126 (18%)	83 (12%)	705
Sweden	558 (10%)	2,961 (52%)	2,179 (38%)	1,378 (24%)	801 (14%)	5,698
Switzerland	1,272 (6%)	13,237 (64%)	6,102 (30%)	1,582 (8%)	4,520 (22%)	20,611
Total Europe	*25,719* *(11%)*	*154,315* *(68%)*	*45,772* (20%)	*24,917* (11%)	*20,855* *(9%)*	*225,806*
United States	132,031 (20%)	500,670 (76%)	24,465 (4%)	20,162 (3%)	4,303 (1%)	657,166
Total	157,750 (18%)	654,985 (74%)	70,237 (8%)	45,079 (5%)	25,158 (3%)	882,972

TABLE 1: *(Cont'd)*

INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES

PANEL C. NUMBER OF EPO PATENTS

Ultimate Owner Country	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*	
Austria	1,646 (23%)	4,006 (55%)	1,570 (22%)	876 (12%)	694 (10%)	7,222
Belgium	1,503 (20%)	1,946 (26%)	3,943 (53%)	1,356 (18%)	2,587 (35%)	7,392
Denmark	435 (6%)	4,144 (59%)	2,473 (35%)	992 (14%)	1,481 (21%)	7,052
Finland	1,411 (15%)	7,732 (80%)	466 (5%)	311 (3%)	155 (2%)	9,609
France	2,278 (5%)	20,676 (45%)	23,011 (50%)	11,461 (25%)	11,550 (25%)	45,965
Germany	26,448 (15%)	135,220 (76%)	16,137 (9%)	5,188 (3%)	10,949 (6%)	177,805
Great Britain	5,229 (13%)	30,809 (78%)	3,493 (9%)	2,862 (7%)	631 (2%)	39,531
Greece	30 (94%)	2 (6%)	0 (0%)	0 (0%)	0 (0%)	32
Italy	5,312 (43%)	3,763 (30%)	3,412 (27%)	1,092 (9%)	2,320 (19%)	12,487
Netherlands	669 (2%)	26,693 (89%)	2,775 (9%)	2,147 (7%)	628 (2%)	30,137
Norway	1,063 (69%)	263 (17%)	213 (14%)	107 (7%)	106 (7%)	1,539
Republic of Ireland	147 (41%)	51 (14%)	164 (45%)	155 (43%)	9 (2%)	362
Spain	873 (53%)	407 (25%)	364 (22%)	148 (9%)	216 (13%)	1,644
Sweden	1,527 (9%)	10,907 (66%)	4,024 (24%)	2,522 (15%)	1,502 (9%)	16,458
Switzerland	3,160 (10%)	19,587 (63%)	8,292 (27%)	1,595 (5%)	6,697 (22%)	31,039
Total Europe	*51,731* *(13%)*	*266,206* *(69%)*	*70,337* (18%)	*30,812* (8%)	*39,525* *(10%)*	*388,274*
United States	23,970 (10%)	198,006 (86%)	8,013 (3%)	4,596 (2%)	3,417 (1%)	229,989
Total	75,701 (12%)	464,212 (75%)	78,350 (13%)	35,408 (6%)	42,942 (7%)	618,263

TABLE 1: *(Cont'd)*

INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES

PANEL D. NUMBER OF PUBLICATIONS

Ultimate Owner Country	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*	
Austria	262 (27%)	493 (51%)	208 (22%)	121 (13%)	87 (9%)	963
Belgium	379 (30%)	316 (25%)	553 (44%)	252 (20%)	301 (24%)	1,248
Denmark	170 (9%)	1,308 (67%)	465 (24%)	58 (3%)	407 (21%)	1,943
Finland	326 (45%)	225 (31%)	166 (23%)	143 (20%)	23 (3%)	717
France	998 (11%)	3,500 (38%)	4,660 (51%)	4,100 (45%)	560 (6%)	9,158
Germany	4,100 (19%)	12,551 (60%)	4,425 (21%)	741 (4%)	3,684 (17%)	21,076
Great Britain	2,672 (32%)	4,609 (55%)	1,136 (13%)	1,059 (13%)	77 (1%)	8,417
Greece	19 (76%)	4 (16%)	2 (8%)	0 (0%)	2 (8%)	25
Italy	614 (50%)	398 (33%)	206 (17%)	74 (6%)	132 (11%)	1,218
Netherlands	257 (11%)	1,445 (62%)	634 (27%)	472 (20%)	162 (7%)	2,336
Norway	237 (60%)	87 (22%)	73 (18%)	47 (12%)	26 (7%)	397
Republic of Ireland	17 (19%)	55 (63%)	16 (18%)	15 (17%)	1 (1%)	88
Spain	220 (44%)	90 (18%)	187 (38%)	66 (13%)	121 (24%)	497
Sweden	278 (21%)	517 (40%)	504 (39%)	319 (25%)	185 (14%)	1,299
Switzerland	1,066 (7%)	11,648 (80%)	1,859 (13%)	298 (2%)	1,561 (11%)	14,573
Total Europe	*11,615* *(18%)*	*37,246* *(58%)*	*15,094* (24%)	*7,765* (12%)	*7,329* *(11%)*	63,955
United States	40,362 (28%)	94,142 (66%)	7,206 (5%)	6,075 (4%)	1,131 (1%)	*141,710*
Total	51,977 (25%)	131,388 (64%)	22,300 (11%)	13,840 (7%)	8,460 (4%)	205,665

TABLE 2:

PRIVATE AND PUBLIC INNOVATING FIRMS

	Number of Firms			USPTO Patents			EPO Patents		
Ultimate Owner Country	Private	Public	Total	Private	Public	Total	Private	Public	Total
Austria	764 (97%)	26 (3%)	790	1,719 (70%)	722 (30%)	2,441	6,096 (84%)	1,126 (16%)	7,222
Belgium	711 (96%)	33 (4%)	744	2,482 (53%)	2,163 (47%)	4,645	4,466 (60%)	2,926 (40%)	7,392
Denmark	443 (95%)	23 (5%)	466	2,067 (55%)	1,666 (45%)	3,733	2,859 (41%)	4,193 (59%)	7,052
Finland	868 (95%)	48 (5%)	916	1,329 (24%)	4,244 (76%)	5,573	2,319 (24%)	7,290 (76%)	9,609
France	2,229 (94%)	135 (6%)	2,364	24,988 (91%)	2,377 (9%)	27,365	37,746 (82%)	8,219 (18%)	45,965
Germany	6,678 (98%)	150 (2%)	6,828	46,172 (43%)	61,851 (57%)	108,023	79,498 (45%)	98,307 (55%)	177,805
Great Britain	4,836 (97%)	144 (3%)	4,980	23,108 (74%)	8,000 (26%)	31,108	26,594 (67%)	12,937 (33%)	39,531
Greece	25 (78%)	7 (22%)	32	18 (86%)	3 (14%)	21	29 (91%)	3 (9%)	32
Italy	3,075 (99%)	44 (1%)	3,119	5,580 (97%)	183 (3%)	5,763	11,652 (93%)	835 (7%)	12,487
Netherlands	615 (96%)	28 (4%)	643	3,000 (33%)	6,199 (67%)	9,199	4,729 (16%)	25,408 (84%)	30,137
Norway	504 (96%)	23 (4%)	527	482 (72%)	190 (28%)	672	876 (57%)	663 (43%)	1,539
Republic of Ireland	87 (98%)	2 (2%)	89	216 (87%)	33 (13%)	249	336 (93%)	26 (7%)	362
Spain	677 (96%)	29 (4%)	706	687 (97%)	18 (3%)	705	1,522 (93%)	122 (7%)	1,644
Sweden	1,024 (94%)	60 (6%)	1,084	4,120 (72%)	1,578 (28%)	5,698	14,010 (85%)	2,448 (15%)	16,458
Switzerland	1,407 (97%)	45 (3%)	1,452	13,710 (67%)	6,901 (33%)	20,611	22,251 (72%)	8,788 (28%)	31,039
Total Europe	*23,943* *(97%)*	*797* *(3%)*	*24,740*	*129,678* *(57%)*	*96,128* *(43%)*	*225,806*	*214,983* *(55%)*	*173,291* *(45%)*	*388,274*
United States	37,801 (96%)	1,491 (4%)	39,292	248,715 (38%)	408,451 (62%)	657,166	71,879 (31%)	158,110 (69%)	229,989
Total	61,744 (96%)	2,288 (4%)	64,032	378,393 (43%)	504,579 (57%)	882,972	286,862 (46%)	331,401 (54%)	618,263

TABLE 3:

PANEL A. TOP 20 INNOVATING AMERICAN FIRMS

	Company name	Firm public	Group public	Total Group Patents USPTO	Patents USPTO	Patents EPO	Publications	Ultimate Owner	Organizational form	Apex
(1)	IBM	Yes	Yes	43,241	43,125	14,319	0	IBM	Conglomerate	Yes
(2)	General Electric	Yes	Yes	22,348	21,830	9,641	93	General Electric	Conglomerate	Yes
(3)	Eastman Kodak	Yes	Yes	17,441	17,157	9,676	3,361	Legg Mason	Conglomerate	Yes
(4)	Motorola	Yes	Yes	17,639	16,380	4,839	2,409	Motorola	Conglomerate	Yes
(5)	Micron Technology	Yes	Yes	13,986	13,986	561	119	Micron Technology	Conglomerate	Yes
(6)	Intel	Yes	Yes	12,936	12,934	2,103	2,285	Intel	Conglomerate	Yes
(7)	Texas Instruments	Yes	Yes	12,695	12,668	3,180	2,989	Texas Instruments	Conglomerate	Yes
(8)	Xerox	Yes	Yes	12,636	12,635	4,402	3,761	Xerox	Conglomerate	Yes
(9)	E.I. du Pont de Nemours	Yes	Yes	11,198	10,700	6,967	9,343	E.I. du Pont de Nemours	Conglomerate	Yes
(10)	3M	Yes	Yes	10,806	10,640	8,796	501	3M	Conglomerate	Yes
(11)	General Motors	Yes	Yes	9,392	9,275	1,643	162	General Motors	Conglomerate	Yes
(12)	Hewlett Packard	Yes	Yes	9,150	9,028	5,181	2,042	Hewlett Packard	Conglomerate	Yes
(13)	Advanced Micro Systems	Yes	Yes	8,466	8,466	685	518	Advanced Micro Systems	Conglomerate	Yes
(14)	Ford Motor	Yes	Yes	7,349	7,321	1,586	2,653	Ford	Conglomerate	Yes
(15)	Procter & Gamble	Yes	Yes	7,522	6,417	8,463	2,534	Procter & Gamble	Conglomerate	Yes
(16)	Microsoft	Yes	Yes	5,888	6,864	2,460	660	Microsoft	Conglomerate	Yes
(17)	Sun Microsystems	Yes	Yes	6,452	5,641	2,193	472	Sun Microsystems	Conglomerate	Yes
(18)	Boeing	Yes	Yes	6,072	4,981	1,384	1,307	Boeing	Conglomerate	Yes
(19)	United Technologies	Yes	Yes	7,151	4,297	2,002	6	United Technologies	Conglomerate	Yes
(20)	Applied Materials	Yes	Yes	3,842	3,842	1,109	0	Applied Materials	Conglomerate	Yes

TABLE 3: *(Cont'd)*

PANEL B. TOP 20 INNOVATING BRITISH FIRMS

	Company name	Firm public	Group public	Total Group Patents USPTO	Patents USPTO	Patents EPO	Publications	Ultimate Owner	Organizational form	Apex
(1)	Imperial Chemical Industries	Yes	Yes	4,147	3,178	2,410	0	Imperial Chemical Industries	Conglomerate	Yes
(2)	Rolls Royce	Yes	Yes	1,288	1,242	805	379	Rolls Royce	Conglomerate	Yes
(3)	British Telecommunications	Yes	Yes	1,074	1,073	1,848	0	British Telecommunications	Conglomerate	Yes
(4)	Beecham Group	No	Yes	3,326	743	801	0	GlaxoSmithKline	Conglomerate	No
(5)	BOC	Yes	Yes	692	686	504	4	BOC	Conglomerate	Yes
(6)	British Technology Group	Yes	Yes	590	590	1,201	2	BTG	Conglomerate	Yes
(7)	BP Chemicals	No	Yes	4,917	583	728	0	BP	Conglomerate	No
(8)	Glaxo Group	No	Yes	3,326	506	1,377	0	GlaxoSmithKline	Conglomerate	No
(9)	The British Petroleum	Yes	Yes	4,917	499	531	0	BP	Conglomerate	Yes
(10)	SmithKline Beecham	No	Yes	3,326	440	1,101	5	GlaxoSmithKline	Conglomerate	No
(11)	Johnson Matthey	Yes	Yes	314	300	384	24	Johnson Metthey	Conglomerate	Yes
(12)	Merck Sharp & Dohme	No	Yes	4,408	300	323	107	Merck	Conglomerate	No
(13)	Smiths Industries	No	Yes	530	293	141	0	Smiths Group	Conglomerate	No
(14)	Molins	Yes	Yes	293	287	78	0	Molins	Stand Alone	Yes
(15)	British Gas	No	Yes	274	274	211	0	Centrica	Business-Group, Wholly-Owned	No
(16)	John Wyeth & Brother	No	Yes	1,957	253	77	7	Wyeth	Conglomerate	No
(17)	Renishaw	Yes	Yes	215	214	308	9	Renishaw	Conglomerate	Yes
(18)	ARM	Yes	Yes	272	184	64	12	ARM	Conglomerate	Yes
(19)	BAE Systems	Yes	Yes	490	128	282	0	BAE Systems	Conglomerate	Yes
(20)	Qinetiq	Yes	Yes	245	122	489	0	Qinetiq	Conglomerate	Yes

TABLE 3: *(Cont'd)*

PANEL C. TOP 20 INNOVATING FRENCH FIRMS

	Company name	Firm public	Group public	Total Group Patents USPTO	Patents USPTO	Patents EPO	Publications	Ultimate Owner	Organizational form	Apex
(1)	L'Oreal	Yes	Yes	4,882	3,135	4,066	0	Nestlé	Business-Group, Partly-Owned	No
(2)	Thales	Yes	No	2,652	2,604	3,438	0	TSA	Business-Group, Partly-Owned	No
(3)	Valeo	Yes	Yes	890	586	291	1	Valeo	Conglomerate	Yes
(4)	France Telecom	Yes	Yes	543	525	1,839	1	France Telecom	Conglomerate	Yes
(5)	Thomson Licensing	No	Yes	536	498	2,671	0	Thomson	Conglomerate	No
(6)	Hutchinson	No	Yes	383	259	509	1	Total	Business-Group, Wholly-Owned	No
(7)	Rhone Poulnec Biochimie	No	Yes	6,465	187	6	0	Sanofi Aventis	Conglomerate	No
(8)	Automobiles Peugeot	No	No	219	150	1,177	0	ETS Peugeot-Frères	Business-Group, Partly-Owned	No
(9)	Valois	No	Yes	203	128	248	0	Aptargroup	Conglomerate	No
(10)	ELA Medical	No	No	245	123	96	0	Fingruppo	Business-Group, Partly-Owned	No
(11)	Airbus France	No	Yes	565	112	353	9	Lagardere	Business-Group, Partly-Owned	No
(12)	Nexans	Yes	Yes	131	105	344	0	Nexans	Conglomerate	Yes
(13)	Saint Gobain Glass France	No	Yes	469	102	475	0	Saint Gobain	Business-Group, Wholly-Owned	No
(14)	Kuhn	No	Yes	121	95	279	0	Bucher Industries	Conglomerate	No
(15)	Gaz De France	Yes	Yes	88	88	211	2	Gaz De France	Conglomerate	Yes
(16)	Valeo Vision	No	Yes	890	84	598	0	Valeo	Business-Group, Wholly-Owned	No
(17)	Somfy	No	No	91	82	219	0	J.P.J Holding company	Business-Group, Partly-Owned	No
(18)	Valeo Equipment Electriques Moteur	No	Yes	890	81	296	0	Valeo	Business-Group, Wholly-Owned	No
(19)	Transgene	Yes	No	67	67	137	331	TSGH	Stand Alone	No
(20)	Gemplus	No	Yes	68	64	325	9	Gemalto	Business-Group, Partly-Owned	No

TABLE 3: *(Cont'd)*

PANEL D. TOP 20 INNOVATING GERMAN FIRMS

	Company name	Firm public	Group public	Total Group Patents USPTO	Patents USPTO	Patents EPO	Publications	Ultimate Owner	Organizational form	Apex
(1)	Siemens	Yes	Yes	31,999	29,156	52,566	4,263	Siemens	Conglomerate	Yes
(2)	Robert Bosch Stiftung	No	No	10,437	10,437	13,832	10	Robert Bosch Stiftung	Conglomerate	Yes
(3)	Bayer	Yes	Yes	11,501	9,969	10,913	0	Bayer	Conglomerate	Yes
(4)	BASF	Yes	Yes	9,659	9,009	11,331	2,654	BASF	Conglomerate	Yes
(5)	Hoechst	No	Yes	6,465	5,364	5,868	2,600	Sanofi Aventis	Conglomerate	No
(6)	Infineon Technologies	Yes	Yes	4,107	3,914	4,044	0	Infineon Technologies	Conglomerate	Yes
(7)	DaimlerChrysler	Yes	Yes	1,903	1,894	2,241	7	Daimler	Conglomerate	Yes
(8)	Heidelberger Druckmaschinen	Yes	Yes	1,755	1,748	1,138	4	Heidelberger Druckmaschinen	Conglomerate	Yes
(9)	Henkel	Yes	Yes	1,565	1,438	4,008	14	Henkel	Stand Alone	Yes
(10)	Atecs Mannesmann	No	Yes	1,408	1,408	1,186	0	Vodafone	Stand Alone	No
(11)	AGFA Gevaert	Yes	Yes	2,850	1,049	742	51	KBC Group	Conglomerate	No
(12)	Porsche	Yes	Yes	1,492	903	26	4	Porsche	Conglomerate	Yes
(13)	ZF Friedrichshafen	No	No	881	865	1,031	6	Zeppelin Stiftung	Business-Group, Partly-Owned	No
(14)	Man Roland Druckmaschinen	No	Yes	928	822	1,263	1	Allianz SE	Business-Group, Partly-Owned	No
(15)	Wacker Chemie	Yes	No	922	728	1,019	0	Dr Alexander Wacker	Business-Group, Partly-Owned	No
(16)	BMW	Yes	Yes	708	708	2,866	0	BMW	Conglomerate	Yes
(17)	Schering	No	Yes	11,501	552	1,116	2,217	Bayer	Conglomerate	No
(18)	Degussa	No	Yes	630	548	894	6	RWE	Business-Group, Partly-Owned	No
(19)	Alfred Teves	No	Yes	698	485	80	0	Continental	Conglomerate	No
(20)	Volkswagen	Yes	Yes	1,492	440	0	140	Porsche	Business-Group, Partly-Owned	No

TABLE 3: *(Cont'd)*

PANEL E. TOP 20 INNOVATING ITALIAN FIRMS

	Company name	Firm public	Group public	Total Group Patents USPTO	Patents USPTO	Patents EPO	Publications	Ultimate Owner	Type of Ownership	Apex
(1)	Montedison	No	Yes	396	396	251	88	State of France	Business-Group, Partly-Owned	No
(2)	Biofarmitalia	No	No	336	336	148	0	Biofarmitalia	Stand Alone	Yes
(3)	Fiat Auto	No	No	306	237	784	7	Giovanni Agnelli & C.	Business-Group, Partly-Owned	No
(4)	Gruppo Lepetit	No	Yes	6,465	133	67	46	Sanofi Aventis	Business-Group, Partly-Owned	No
(5)	Zambon Group	No	No	108	108	121	1	Zambon	Business-Group, Wholly-Owned	No
(6)	GD	No	No	96	96	123	0	GD	Conglomerate	Yes
(7)	Indena	No	No	94	93	134	62	IdB Holding	Business-Group, Wholly-Owned	No
(8)	SKF Industrie	No	Yes	345	57	115	0	SKF	Conglomerate	No
(9)	Arturo Salice	No	No	47	47	125	0	Giorgio E Luicano Salice	Stand Alone	No
(10)	Solvay Solexis	No	Yes	253	45	273	2	Solvac	Business-Group, Partly-Owned	No
(11)	Chiesi Farmaceutici	No	No	46	45	116	3	Chiesi Farmaceutici	Conglomerate	Yes
(12)	Snamprogetti	No	Yes	163	37	47	91	Eni	Business-Group, Wholly-Owned	No
(13)	Claber	No	No	37	37	1	0	Claber	Stand Alone	Yes
(14)	Dideco	No	No	245	33	26	11	Fingruppo	Business-Group, Partly-Owned	No
(15)	Magneti Marelli PowerTrain	No	No	306	32	126	0	Giovanni Agnelli & C.	Business-Group, Partly-Owned	No
(16)	Lonati	No	No	66	32	42	0	Lonati	Conglomerate	Yes
(17)	Italfarmaco	No	No	34	31	31	41	Italfarmaco Holding	Business-Group, Wholly-Owned	No
(18)	Eni	Yes	Yes	163	30	123	5	Eni	Conglomerate	Yes
(19)	ACRAF	No	No	30	29	49	0	APO Conerpo	Business-Group, Partly-Owned	No
(20)	Esaote	No	Yes	40	27	9	0	Intesa Sanpaolo	Business-Group, Partly-Owned	No

TABLE 4:

COMPARING ORGANIZATIONAL FORM BY COUNTRY FINANCIAL AND LEGAL CONDITIONS

PANEL A. EPO PATENTS

	Market Capitalization		Minority Shareholders Protection		U.S. & U.K. vs. Con. Europe	
	Lower 25%	*Top 25%*	Lower 25%	*Top 25%*	*United States & Great Britain*	*Continental Europe*
% Partly-owned Affiliates	20.6%	1.6%	9.3%	1.5%	1.5%	11.2%
Partly-owned / Conglomerates	0.58	0.02	0.13	0.02	0.02	0.17
Standalones / Conglomerates	0.87	0.13	0.20	0.13	0.13	0.20
Partly-owned / Standalones	0.66	0.14	0.65	0.14	0.14	0.84
% Public	18.0%	63.1%	51.8%	63.5%	63.5%	46.0%

PANEL B. USPTO PATENTS

	Market Capitalization		Minority Shareholders Protection		U.S. & U.K. vs. Con. Europe	
	Lower 25%	*Top 25%*	Lower 25%	*Top 25%*	*United States & Great Britain*	*Continental Europe*
% Partly-owned Affiliates	24.1%	0.7%	9.4%	0.6%	0.6%	10.6%
Partly-owned / Conglomerates	0.77	0.01	0.13	0.01	0.01	0.16
Standalones / Conglomerates	1.06	0.26	0.16	0.26	0.26	0.16
Partly-owned / Stand Alones	0.73	0.03	0.80	0.03	0.03	0.99
% Public	23.9%	60.4%	51.6%	60.5%	60.5%	45.3%

PANEL C. SCIENTIFIC PUBLICATIONS

	Market Capitalization		Minority Shareholders Protection		U.S. & U.K. vs. Con. Europe	
	Lower 25%	*Top 25%*	Lower 25%	*Top 25%*	*United States & Great Britain*	*Continental Europe*
% Partly-owned Affiliates	15.1%	0.9%	14.6%	0.8%	0.8%	13.1%
Partly-owned / Conglomerates	0.43	0.01	0.22	0.01	0.01	0.22
Standalones / Conglomerates	1.05	0.44	0.24	0.44	0.44	0.27
Partly-owned / Stand Alones	0.41	0.03	0.92	0.03	0.03	0.81
% Public	14.9%	63.5%	58.8%	63.6%	63.6%	61.9%

Notes: This table examines the distribution of organizational form by country financial and legal conditions. For Market Capitalization, We rank countries according to the three-year average ratio of stock-market traded value to GDP, based on Beck et al. (2000, 2007). We use the anti-directive index developed by La Porta et al. (1997) to rank countries according to the strength of minority shareholders protection. The business-group category includes only partly-owned affiliates.

TABLE 5:

INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES AND SELECTED INDUSTRIES: NUMBER OF EPO PATENTS

Ultimate owner Country:	*Pharmaceuticals*						*Biotechnology*					
	Stand Alone	Conglomerate	Business-Group			Total	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*				*Total affiliates*	*Wholly-owned*	*Minority Shareholders*	
Austria	41	624	2	0	2	667	19	147	3	2	1	169
	(6%)	(94%)	(0%)	(0%)	(0%)		(11%)	(87%)	(2%)	(1%)	(1%)	
Belgium	46	11	191	135	56	248	39	11	30	15	15	80
	(19%)	(4%)	(77%)	(54%)	(23%)		(49%)	(14%)	(38%)	(19%)	(19%)	
Denmark	31	404	97	4	93	532	27	315	508	22	486	850
	(6%)	(76%)	(18%)	(1%)	(17%)		(3%)	(37%)	(60%)	(3%)	(57%)	
Finland	63	64	0	0	0	127	51	10	6	6	0	67
	(50%)	(50%)	(0%)	(0%)	(0%)		(76%)	(15%)	(9%)	(9%)	(0%)	
France	132	1,296	284	115	169	1,712	134	522	124	46	78	780
	(8%)	(76%)	(17%)	(7%)	(10%)		(17%)	(67%)	(16%)	(6%)	(10%)	
Germany	919	2,053	348	74	274	3,320	446	868	194	12	182	1,508
	(28%)	(62%)	(10%)	(2%)	(8%)		(30%)	(58%)	(13%)	(1%)	(12%)	
Great Britain	190	4,732	229	156	73	5,151	179	1,457	160	122	38	1,796
	(4%)	(92%)	(4%)	(3%)	(1%)		(10%)	(81%)	(9%)	(7%)	(2%)	
Greece	7	0	0	0	0	7	-	-				-
	(100%)	(0%)	(0%)	(0%)	(0%)							
Italy	420	212	79	5	74	711	101	20	24	1	23	145
	(59%)	(30%)	(11%)	(1%)	(10%)		(70%)	(14%)	(17%)	(1%)	(16%)	
Netherlands	85	205	24	17	7	314	50	104	10	7	3	164
	(27%)	(65%)	(8%)	(5%)	(2%)		(30%)	(63%)	(6%)	(4%)	(2%)	
Norway	26	5	17	8	9	48	26	1	8	6	2	35
	(54%)	(10%)	(35%)	(17%)	(19%)		(74%)	(3%)	(23%)	(17%)	(6%)	
Republic of Ireland	11	19	52	52	0	82	0	0	15	15	0	15
	(13%)	(23%)	(63%)	(63%)	(0%)		(0%)	(0%)	(100%)	(100%)	(0%)	
Spain	175	13	44	14	30	232	11	7	6	3	3	24
	(75%)	(6%)	(19%)	(6%)	(13%)		(46%)	(29%)	(25%)	(13%)	(13%)	
Sweden	40	57	139	77	62	236	2	31	36	5	31	64
	(17%)	(24%)	(59%)	(33%)	(26%)		(3%)	(48%)	(56%)	(8%)	(48%)	
Switzerland	134	1,980	538	75	463	2,652	28	973	714	22	692	1,715
	(5%)	(75%)	(20%)	(3%)	(17%)		(2%)	(57%)	(42%)	(1%)	(40%)	
Total Europe	*2,320*	*11,675*	*2,044*	*732*	*1,312*	*16,039*	*1,113*	*4,466*	*1,838*	*284*	*1,554*	*7,417*
	(14%)	*(73%)*	(13%)	(5%)	*(8%)*		*(15%)*	*(60%)*	(25%)	(4%)	*(21%)*	
United States	1,487	7,361	327	222	105	9,175	1,271	2,971	204	184	20	4,446
	(16%)	(80%)	(4%)	(2%)	(1%)		(29%)	(67%)	(5%)	(4%)	(0%)	
Total	3,807	19,036	2,371	954	1,417	25,214	2,384	7,437	2,042	468	1,574	11,863
	(15%)	(75%)	(9%)	(4%)	(6%)		(20%)	(63%)	(17%)	(4%)	(13%)	

TABLE 5: *(Cont'd)*

INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES AND SELECTED INDUSTRIES: NUMBER OF EPO PATENTS

	Computer Hardware						*Telecommunications*					
Ultimate owner Country:	Stand Alone	Conglomerate	Business-Group			Total	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*				*Total affiliates*	*Wholly-owned*	*Minority Shareholders*	
Austria	9	7	2	2	0	18	34	10	1	1	0	45
	(50%)	(39%)	(11%)	(11%)	(0%)		(76%)	(22%)	(2%)	(2%)	(0%)	
Belgium	5	1	3	2	1	9	65	95	93	3	90	253
	(56%)	(11%)	(33%)	(22%)	(11%)		(26%)	(38%)	(37%)	(1%)	(1000%)	
Denmark	3	3	2	1	1	8	0	20	3	2	1	23
	(38%)	(38%)	(25%)	(13%)	(13%)		(0%)	(87%)	(13%)	(9%)	(13%)	
Finland	19	156	11	2	9	186	60	3,104	19	3	16	3,183
	(10%)	(84%)	(6%)	(1%)	(5%)		(2%)	(98%)	(1%)	(0%)	(9%)	
France	27	214	176	100	76	417	121	3,852	2,767	2,145	622	6,740
	(6%)	(51%)	(42%)	(24%)	(18%)		(2%)	(57%)	(41%)	(32%)	(149%)	
Germany	64	1,060	38	11	27	1,162	373	6,059	217	129	88	6,649
	(6%)	(91%)	(3%)	(1%)	(2%)		(6%)	(91%)	(3%)	(2%)	(8%)	
Great Britain	79	69	18	13	5	166	163	318	89	68	21	570
	(48%)	(42%)	(11%)	(8%)	(3%)		(29%)	(56%)	(16%)	(12%)	(13%)	
Italy	5	11	5	1	4	21	55	193	54	42	12	302
	(24%)	(52%)	(24%)	(5%)	(19%)		(18%)	(64%)	(18%)	(14%)	(57%)	
Netherlands	1	424	33	21	12	458	0	4,759	180	98	82	4,939
	(0%)	(93%)	(7%)	(5%)	(3%)		(0%)	(96%)	(4%)	(2%)	(18%)	
Norway	11	3	0	0	0	14	55	45	2	2	0	102
	(79%)	(21%)	(0%)	(0%)	(0%)		(54%)	(44%)	(2%)	(2%)	(0%)	
Republic of Ireland	2	0	0	0	0	2	5	1	0	0	0	6
	(100%)	(0%)	(0%)	(0%)	(0%)		(83%)	(17%)	(0%)	(0%)	(0%)	
Spain	1	0	3	0	3	4	10	22	16	12	4	48
	(25%)	(0%)	(75%)	(0%)	(75%)		(21%)	(46%)	(33%)	(25%)	(100%)	
Sweden	7	117	9	6	3	133	20	2,845	77	70	7	2,942
	(5%)	(88%)	(7%)	(5%)	(2%)		(1%)	(97%)	(3%)	(2%)	(5%)	
Switzerland	8	15	11	1	10	34	124	150	14	9	5	288
	(24%)	(44%)	(32%)	(3%)	(29%)		(43%)	(52%)	(5%)	(3%)	(15%)	
Total Europe	*241*	*2,080*	*311*	*160*	*151*	*2,632*	*1,085*	*21,473*	*3,532*	*2,584*	*948*	*26,090*
	(9%)	*(79%)*	*(12%)*	*(6%)*	*(6%)*		*(4%)*	*(82%)*	*(14%)*	*(10%)*	*(4%)*	
United States	393	3,796	43	40	3	4,232	1,259	12,813	135	102	33	14,207
	(9%)	(90%)	(1%)	(1%)	(0%)		(9%)	(90%)	(1%)	(1%)	(0%)	
Total	634	5,876	354	200	154	6,864	2,344	34,286	3,667	2,686	981	40,297
	(9%)	(86%)	(5%)	(3%)	(2%)		(6%)	(85%)	(9%)	(7%)	(2%)	

TABLE 6:

COMPARISON OF MEANS: CONGLOMERATES VS. BUSINESS-GROUPS

Panel A. United States & Great Britain

		Conglomerates			Business-Groups		
Variable	Cong - BG	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Weighted Citations per patent	0.111 ***	522,437	1.231	2.654	31,645	1.120	2.292
Weighted Citations per patent - 3 year window	0.065 ***	515,961	1.208	2.689	31,254	1.143	2.464
Weighted Citations per patent - 5 year window	0.084 ***	515,961	1.224	2.635	31,254	1.140	2.342
Weighted Self citations per patent - 5 year window	0.592 ***	515,961	1.567	5.173	31,254	0.975	3.539
Generality	0.012 ***	254,863	0.278	0.282	16,015	0.266	0.278
Originality	0.010 ***	385,689	0.274	0.284	22,985	0.264	0.282

Panel B. Continental Europe

		Conglomerates			Business-Groups		
Variable	Cong - BG	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Weighted Citations per patent	-0.169 ***	117,884	0.713	2.015	40,370	0.883	2.050
Weighted Citations per patent - 3 year window	-0.161 ***	116,414	0.772	2.155	39,806	0.932	2.172
Weighted Citations per patent - 5 year window	-0.162 ***	116,414	0.759	2.074	39,806	0.920	2.091
Weighted Self citations per patent - 5 year window	-0.019	116,414	0.598	2.570	39,806	0.617	2.778
Generality	-0.033 ***	47,125	0.231	0.273	18,757	0.264	0.281
Originality	-0.013 ***	75,341	0.226	0.273	27,468	0.239	0.277

Notes: This table reports mean comparison tests for measures of patent quality between conglomerates and partly-owned business group affiliates. The unit of observation is patents from the USPTO over the period 1969-2007. Self citations are citations where the citing firm cites one of its predecessor patents. Generality is defined as one minus the Herfindahl-Hirschman Index of the concentration of the citations a patent receives across three-digit technology fields. Originality is defined as one minus the Herfindahl-Hirschman Index of the concentration of the citations a patent receives across three-digit technology fields. *** indicates that the difference in means in significant at the one percent level.

TABLE 7:

PANEL A: INCLUDING NON-INNOVATING FIRMS

Ultimate owner Country:	EPO Patents: Stand Alone	EPO Patents: Conglomerate	EPO Patents: Business-Group			EPO Patents: Total	Sales ($M): Stand Alone	Sales ($M): Conglomerate	Sales ($M): Business-Group			Sales ($M): Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*				*Total affiliates*	*Wholly-owned*	*Minority Shareholders*	
Austria	1,646	4,006	1,570	876	694	7,222	112,331	282,728	184,851	149,687	35,165	579,910
	(23%)	(55%)	(22%)	(12%)	(10%)		(19%)	(49%)	(32%)	(26%)	(6%)	
Belgium	1,503	1,946	3,943	1,356	2,587	7,392	318,930	270,565	281,023	149,940	131,083	870,518
	(20%)	(26%)	(53%)	(18%)	(35%)		(37%)	(31%)	(32%)	(17%)	(15%)	
Denmark	435	4,144	2,473	992	1,481	7,052	65,155	57,801	110,935	68,324	42,611	233,890
	(6%)	(59%)	(35%)	(14%)	(21%)		(28%)	(25%)	(47%)	(29%)	(18%)	
Finland	1,411	7,732	466	311	155	9,609	157,591	341,274	94,689	46,669	48,020	593,554
	(15%)	(80%)	(5%)	(3%)	(2%)		(27%)	(57%)	(16%)	(8%)	(8%)	
France	2,278	20,676	23,011	11,461	11,550	45,965	983,506	2,426,349	3,142,541	1,096,336	2,046,205	6,552,396
	(5%)	(45%)	(50%)	(25%)	(25%)		(15%)	(37%)	(48%)	(17%)	(31%)	
Germany	26,448	135,220	16,137	5,188	10,949	177,805	3,184,594	4,179,662	1,979,268	745,130	1,234,138	9,343,524
	(15%)	(76%)	(9%)	(3%)	(6%)		(34%)	(45%)	(21%)	(8%)	(13%)	
Great Britain	5,229	30,809	3,493	2,862	631	39,531	1,004,820	4,006,807	1,910,309	1,383,107	527,202	6,921,935
	(13%)	(78%)	(9%)	(7%)	(2%)		(15%)	(58%)	(28%)	(20%)	(8%)	
Greece	30	2	0	0	0	32	92,488	45,221	31,725	8,216	23,509	169,434
	(94%)	(6%)	(0%)	(0%)	(0%)		(55%)	(27%)	(19%)	(5%)	(14%)	
Italy	5,312	3,763	3,412	1,092	2,320	12,487	1,251,114	515,623	463,700	262,265	201,436	2,230,437
	(43%)	(30%)	(27%)	(9%)	(19%)		(56%)	(23%)	(21%)	(12%)	(9%)	
Netherlands	669	26,693	2,775	2,147	628	30,137	692,932	891,044	742,451	512,979	229,472	2,326,426
	(2%)	(89%)	(9%)	(7%)	(2%)		(30%)	(38%)	(32%)	(22%)	(10%)	
Norway	1,063	263	213	107	106	1,539	273,878	247,768	161,400	89,753	71,647	683,045
	(69%)	(17%)	(14%)	(7%)	(7%)		(40%)	(36%)	(24%)	(13%)	(10%)	
Republic of Ireland	147	51	164	155	9	362	326,369	146,663	58,731	50,586	8,145	531,762
	(41%)	(14%)	(45%)	(43%)	(2%)		(61%)	(28%)	(11%)	(10%)	(2%)	
Spain	873	407	364	148	216	1,644	934,822	887,995	688,147	201,559	486,588	2,510,965
	(53%)	(25%)	(22%)	(9%)	(13%)		(37%)	(35%)	(27%)	(8%)	(19%)	
Sweden	1,527	10,907	4,024	2,522	1,502	16,458	211,686	488,545	498,265	274,883	223,381	1,198,495
	(9%)	(66%)	(24%)	(15%)	(9%)		(18%)	(41%)	(42%)	(23%)	(19%)	
Switzerland	3,160	19,587	8,292	1,595	6,697	31,039	204,994	976,556	319,395	131,275	188,120	1,500,944
	(10%)	(63%)	(27%)	(5%)	(22%)		(14%)	(65%)	(21%)	(9%)	(13%)	
Total Europe	*51,731*	*266,206*	*70,337*	*30,812*	*39,525*	*388,274*	*9,815,208*	*15,764,599*	*10,667,428*	*5,170,707*	*5,496,721*	*36,247,235*
	(13%)	*(69%)*	*(18%)*	*(8%)*	*(10%)*		*(27%)*	*(43%)*	*(29%)*	(14%)	(15%)	
United States	23,970	198,006	8,013	4,596	3,417	229,989	8,811,427	21,377,492	2,763,126	2,147,748	615,378	32,952,045
	(10%)	(86%)	(3%)	(2%)	(1%)		(27%)	(65%)	(8%)	(7%)	(2%)	
Total	75,701	464,212	78,350	35,408	42,942	618,263	18,626,635	37,142,091	13,430,554	7,318,455	6,112,099	69,199,280
	(12%)	(75%)	(13%)	(6%)	(7%)		(27%)	(54%)	(19%)	(11%)	(9%)	

TABLE 7:

PANEL B: INCLUDING NON-INNOVATING FIRMS - PHARMACEUTICALS AND BIOTECHNOLOGY

	EPO Patents						Sales ($M)					
Ultimate owner Country:	Stand Alone	Conglomerate	Business-Group			Total	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*				*Total affiliates*	*Wholly-owned*	*Minority Shareholders*	
Austria	60	771	5	2	3	836	4,048	3,448	104	104	0	7,600
	(7%)	(92%)	(1%)	(0%)	(0%)		(53%)	(45%)	(1%)	(1%)	(0%)	
Belgium	85	22	221	150	71	328	15,034	1,504	16,627	13,342	3,285	33,164
	(26%)	(7%)	(67%)	(46%)	(22%)		(45%)	(5%)	(50%)	(40%)	(10%)	
Denmark	58	719	605	26	579	1,382	800	2,507	2,510	933	1,576	5,817
	(4%)	(52%)	(44%)	(2%)	(42%)		(14%)	(43%)	(43%)	(16%)	(27%)	
Finland	114	74	6	6	0	194	3,588	1,289	54	4	50	4,931
	(59%)	(38%)	(3%)	(3%)	(0%)		(73%)	(26%)	(1%)	(0%)	(1%)	
France	266	1,818	408	161	247	2,492	17,941	102,218	13,406	3,462	9,944	133,564
	(11%)	(73%)	(16%)	(6%)	(10%)		(13%)	(77%)	(10%)	(3%)	(7%)	
Germany	1,365	2,921	542	86	456	4,828	56,465	150,206	36,877	2,577	34,300	243,548
	(28%)	(61%)	(11%)	(2%)	(9%)		(23%)	(62%)	(15%)	(1%)	(14%)	
Great Britain	369	6,189	389	278	111	6,947	8,832	162,238	4,868	4,049	819	175,939
	(5%)	(89%)	(6%)	(4%)	(2%)		(5%)	(92%)	(3%)	(2%)	(0%)	
Greece	7	0	0	0	0	7	6,172	93	227	0	227	6,493
	(100%)	(0%)	(0%)	(0%)	(0%)		(95%)	(1%)	(3%)	(0%)	(3%)	
Italy	521	232	103	6	97	856	28,844	3,279	7,471	650	6,822	39,594
	(61%)	(27%)	(12%)	(1%)	(11%)		(73%)	(8%)	(19%)	(2%)	(17%)	
Netherlands	135	309	34	24	10	478	10,472	24,164	4,629	3,449	1,180	39,265
	(28%)	(65%)	(7%)	(5%)	(2%)		(27%)	(62%)	(12%)	(9%)	(3%)	
Norway	52	6	25	14	11	83	1,786	523	1,035	964	71	3,343
	(63%)	(7%)	(30%)	(17%)	(13%)		(53%)	(16%)	(31%)	(29%)	(2%)	
Republic of Ireland	11	19	67	67	0	97	7,021	3,349	1,937	431	1,507	12,308
	(11%)	(20%)	(69%)	(69%)	(0%)		(57%)	(27%)	(16%)	(3%)	(12%)	
Spain	186	20	50	17	33	256	22,921	20,705	5,385	1,124	4,261	49,011
	(73%)	(8%)	(20%)	(7%)	(13%)		(47%)	(42%)	(11%)	(2%)	(9%)	
Sweden	42	88	175	82	93	305	5,524	1,799	5,652	3,338	2,315	12,975
	(14%)	(29%)	(57%)	(27%)	(30%)		(43%)	(14%)	(44%)	(26%)	(18%)	
Switzerland	162	2,953	1,252	97	1,155	4,367	8,161	95,671	8,323	1,298	7,025	112,155
	(4%)	(68%)	(29%)	(2%)	(26%)		(7%)	(85%)	(7%)	(1%)	(6%)	
Total Europe	*3,433*	*16,141*	*3,882*	*1,016*	*2,866*	*23,456*	*197,609*	*572,993*	*109,105*	*35,725*	*73,380*	*879,706*
	(15%)	*(69%)*	*(17%)*	*(4%)*	*(12%)*		*(22%)*	*(65%)*	*(12%)*	*(4%)*	*(8%)*	
United States	2,758	10,332	531	406	125	13,621	62,035	841,708	33,146	21,696	11,450	936,889
	(20%)	(76%)	(4%)	(3%)	(1%)		(7%)	(90%)	(4%)	(2%)	(1%)	
Total	6,191	26,473	4,413	1,422	2,991	37,077	259,643	1,414,701	142,251	57,421	84,830	1,816,595
	(17%)	(71%)	(11.9%)	(4%)	(8%)		(14%)	(78%)	(7.8%)	(3%)	(5%)	

TABLE 7:

PANEL C: INCLUDING NON-INNOVATING FIRMS - TELECOMMUNICATIONS

Ultimate owner Country:	EPO Patents						Sales ($M)					
	Stand Alone	Conglomerate	Business-Group			Total	Stand Alone	Conglomerate	Business-Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*				*Total affiliates*	*Wholly-owned*	*Minority Shareholders*	
Austria	34	10	1	1	0	45	243	213	152	152	0	607
	(76%)	(22%)	(2%)	(2%)	(0%)		(40%)	(35%)	(25%)	(25%)	(0%)	
Belgium	65	95	93	3	90	253	130	1,687	28	28	0	1,845
	(26%)	(38%)	(37%)	(1%)	(36%)		(7%)	(91%)	(2%)	(2%)	(0%)	
Denmark	0	20	3	2	1	23	63	81	567	567	0	711
	(0%)	(87%)	(13%)	(9%)	(4%)		(9%)	(11%)	(80%)	(80%)	(0%)	
Finland	60	3,104	19	3	16	3,183	936	58,720	895	0	895	60,551
	(2%)	(98%)	(1%)	(0%)	(1%)		(2%)	(97%)	(1%)	(0%)	(1%)	
France	121	3,852	2,767	2,145	622	6,740	1,315	1,599	28,200	21,665	6,535	31,114
	(2%)	(57%)	(41%)	(32%)	(9%)		(4%)	(5%)	(91%)	(70%)	(21%)	
Germany	373	6,059	217	129	88	6,649	5,293	2,710	16,408	15,953	455	24,410
	(6%)	(91%)	(3%)	(2%)	(1%)		(22%)	(11%)	(67%)	(65%)	(2%)	
Great Britain	163	318	89	68	21	570	663	66,360	5,328	2,528	2,800	72,350
	(29%)	(56%)	(16%)	(12%)	(4%)		(1%)	(92%)	(7%)	(3%)	(4%)	
Greece	-	-	-	-	-	-	143	0	138	0	138	282
							(51%)	(0%)	(49%)	(0%)	(49%)	
Italy	55	193	54	42	12	302	4,567	271	1,067	814	254	5,905
	(18%)	(64%)	(18%)	(14%)	(4%)		(77%)	(5%)	(18%)	(14%)	(4%)	
Netherlands	0	4,759	180	98	82	4,939	0	360	515	512	3	875
	(0%)	(96%)	(4%)	(2%)	(2%)		(0%)	(41%)	(59%)	(59%)	(0%)	
Norway	55	45	2	2	0	102	572	227	114	95	19	914
	(54%)	(44%)	(2%)	(2%)	(0%)		(63%)	(25%)	(12%)	(10%)	(2%)	
Republic of Ireland	5	1	0	0	0	6	39	0	0	0	0	39
	(83%)	(17%)	(0%)	(0%)	(0%)		(100%)	(0%)	(0%)	(0%)	(0%)	
Spain	10	22	16	12	4	48	3,813	305	803	110	693	4,921
	(21%)	(46%)	(33%)	(25%)	(8%)		(77%)	(6%)	(16%)	(2%)	(14%)	
Sweden	20	2,845	77	70	7	2,942	90	13,899	181	148	33	14,169
	(1%)	(97%)	(3%)	(2%)	(0%)		(1%)	(98%)	(1%)	(1%)	(0%)	
Switzerland	124	150	14	9	5	288	193	359	38	38	0	589
	(43%)	(52%)	(5%)	(3%)	(2%)		(33%)	(61%)	(6%)	(6%)	(0%)	
Total Europe	*1,085*	*21,473*	*3,532*	*2,584*	*948*	*26,090*	*18,060*	*146,790*	*54,432*	*42,609*	*11,824*	*219,283*
	(4%)	*(82%)*	*(14%)*	*(10%)*	*(4%)*		*(8%)*	*(67%)*	*(25%)*	*(19%)*	*(5%)*	
United States	1,259	12,813	135	102	33	14,207	126,781	773,582	11,632	6,809	4,822	911,994
	(9%)	(90%)	(1%)	(1%)	(0%)		(14%)	(85%)	(1%)	(1%)	(1%)	
Total	2,344	34,286	3,667	2,686	981	40,297	144,841	920,372	66,064	49,418	16,646	1,131,277
	(6%)	(85%)	(9%)	(7%)	(2%)		(13%)	(81%)	(6%)	(4%)	(1%)	

TABLE A1:

PANEL A: TOP 20 INNOVATING CORPORATIONS - ALL INDUSTRIES

	Group name	Country of ultimate owner	Sales (M, $)	# of employees	Public	Patents USPTO	Patents EPO	Publications	# of subsidiaries	# of patenting subsidiaries
(1)	IBM	USA	91,400	355,766	Public	43,241	14,576	925	198	31
(2)	Siemens	Germany	110,820	427,000	Public	31,999	55,190	4,357	578	101
(3)	General Electric	USA	163,000	319,000	Public	22,348	10,116	237	1,271	72
(4)	Motorola	USA	15,800	24,568	Public	17,639	5,359	2,462	76	23
(5)	Eastman Kodak	USA	10,301	26,900	Public	17,441	9,954	3,371	30	5
(6)	Micron Technology	USA	5,688	23,500	Public	13,986	561	128	11	3
(7)	Intel	USA	37,600	83,900	Public	12,936	2,104	2,291	31	4
(8)	Texas Instruments	USA	14,300	30,986	Public	12,695	3,212	2,992	24	5
(9)	Xerox	USA	12,200	20,355	Public	12,636	4,403	3,761	156	3
(10)	Bayer	Germany	32,918	180,600	Public	11,501	13,322	2,592	146	44
(11)	E.I. Du Pont De Nemours	USA	29,000	59,000	Public	11,198	7,044	9,398	122	17
(12)	3M	USA	22,900	75,333	Public	10,806	8,971	532	97	13
(13)	Robert Bosch Stiftung	Germany	46,320	271,000	Private	10,437	13,832	10	5	1
(14)	BASF	Germany	69,600	87,413	Public	9,659	11,993	2,691	187	26
(15)	General Motors	USA	207,000	280,000	Public	9,392	2,319	189	260	9
(16)	Hewlett Packard	USA	10,400	172,000	Public	9,150	6,798	3,606	151	46
(17)	Alcatel-Lucent	France	19,400	46,096	Public	8,567	7,272	3,659	138	43
(18)	Advanced Micro Devices	USA	5,649	10,626	Public	8,466	685	518	17	1
(19)	Procter & Gamble	USA	76,500	138,000	Public	7,522	9,138	2,645	221	17
(20)	Ford Motor	USA	160,000	283,000	Public	7,349	3,195	2,807	67	18

TABLE A1:

PANEL B: TOP 20 INNOVATING CORPORATIONS - PHARMACEUTICALS

	Group name	Country of ultimate owner	Sales (M, $)	# of employees	Public	Patents USPTO	Patents EPO	Publications	# of subsidiaries	# of patenting subsidiaries
(1)	Bayer	Germany	32,918	180,600	Public	11,501	13,322	2,592	146	44
(2)	3M	USA	22,900	75,333	Public	10,806	8,971	532	97	13
(3)	BASF	Germany	69,600	87,413	Public	9,659	11,993	2,691	187	26
(4)	Procter & Gamble	USA	76,500	138,000	Public	7,522	9,138	2,645	221	17
(5)	Sanofi Aventis	France	22,300	52,096	Public	6,465	7,369	2,954	137	27
(6)	Pfizer	USA	48,400	98,000	Public	5,314	4,475	5,145	147	28
(7)	Roche	Switzerland	10,900	40,689	Public	3,832	4,940	8,755	72	29
(8)	Johnson & Johnson	USA	53,300	122,200	Public	3,570	2,583	664	186	99
(9)	Abbott Laboratories	USA	22,500	66,663	Public	3,476	2,020	4,619	81	14
(10)	Glaxosmithkline	Great Britain	36,400	76,573	Public	3,326	5,432	515	142	25
(11)	Eli Lilly	USA	15,700	41,500	Public	3,246	2,437	5,526	40	8
(12)	Wyeth	USA	20,400	50,060	Public	1,957	795	55	48	8
(13)	Novartis	Switzerland	12,800	65,257	Public	1,703	3,638	3,330	143	30
(14)	Henkel	Germany	16,900	21,716	Public	1,565	4,155	23	39	10
(15)	Novo Nordisk	Denmark	904	22,590	Public	1,456	3,132	1,137	35	10
(16)	Astrazeneca	Great Britain	28,300	30,986	Public	1,366	2,430	682	76	22
(17)	Schering Plough	USA	18,502	50,000	Public	1,275	1,004	1,243	50	5
(18)	Allergan	USA	3,900	5,389	Public	945	548	132	22	6
(19)	CH Boehringer Sohn	Germany	14,300	37,723	Private	744	1,437	1,281	47	18
(20)	BTG	Great Britain	139	95	Public	590	1,201	2	10	1

TABLE A1:

PANEL C: TOP 10 INNOVATING CORPORATIONS - BIOTECHNOLOGY

	Group name	Country of ultimate owner	Sales (M, $)	# of employees	Public	Patents USPTO	Patents EPO	Publications	# of subsidiaries	# of patenting subsidiaries
(1)	Bayer	Germany	32,918	180,600	Public	11,501	13,322	2,592	146	44
(2)	E.I. Du Pont De Nemours	USA	29,000	59,000	Public	11,198	7,044	9,398	122	17
(3)	BASF	Germany	69,600	87,413	Public	9,659	11,993	2,691	187	26
(4)	Sanofi Aventis	France	22,300	52,096	Public	6,465	7,369	2,954	137	27
(5)	Pfizer	USA	48,400	98,000	Public	5,314	4,475	5,145	147	28
(6)	Roche	Switzerland	10,900	40,689	Public	3,832	4,940	8,755	72	29
(7)	Abbott Laboratories	USA	22,500	66,663	Public	3,476	2,020	4,619	81	14
(8)	Glaxosmithkline	Great Britain	36,400	76,573	Public	3,326	5,432	515	142	25
(9)	Eli Lilly	USA	15,700	41,500	Public	3,246	2,437	5,526	40	8
(10)	Monsanto	USA	8,563	18,800	Public	2,961	872	2,095	24	9
(11)	Novartis	Switzerland	12,800	65,257	Public	1,703	3,638	3,330	143	30
(12)	Becton Dickinson	USA	6,359	28,018	Public	1,594	1,247	37	27	8
(13)	Novo Nordisk	Denmark	904	22,590	Public	1,456	3,132	1,137	35	10
(14)	Astrazeneca	Great Britain	28,300	30,986	Public	1,366	2,430	682	76	22
(15)	Schering Plough	USA	18,502	50,000	Public	1,275	1,004	1,243	50	5
(16)	Amgen	USA	14,771	17,500	Public	847	333	3,139	17	13
(17)	CH Boehringer Sohn	Germany	14,300	37,723	Private	744	1,437	1,281	47	18
(18)	Human Genome Sciences	USA	28	770	Public	499	546	0	2	1
(19)	Applera	USA	2,644	8,210	Private	407	534	72	19	17
(20)	Syngeta	Switzerland	4,659	13,398	Public	341	591	37	53	15

TABLE A1:

PANEL D: TOP 10 INNOVATING CORPORATIONS - COMPUTER HARDWATE

	Group name	Country of ultimate owner	Sales (M, $)	# of employees	Public	Patents USPTO	Patents EPO	Publications	# of subsidiaries	# of patenting subsidiaries
(1)	IBM	USA	91,400	355,766	Public	43,241	14,576	925	198	31
(2)	Micron Technology	USA	5,688	23,500	Public	13,986	561	128	11	3
(3)	Intel	USA	37,600	83,900	Public	12,936	2,104	2,291	31	4
(4)	Texas Instruments	USA	14,300	30,986	Public	12,695	3,212	2,992	24	5
(5)	Xerox	USA	12,200	20,355	Public	12,636	4,403	3,761	156	3
(6)	Hewlett Packard	USA	10,400	172,000	Public	9,150	6,798	3,606	151	46
(7)	Advanced Micro Devices	USA	5,649	10,626	Public	8,466	685	518	17	1
(8)	Sun Microsystems	USA	13,900	34,200	Public	6,452	2,252	568	46	7
(9)	LSI	USA	1,982	4,010	Public	3,472	239	6	15	3
(10)	Seagate Technology	USA	12,700	54,000	Public	3,074	200	56	14	4
(11)	Cisco Systems	USA	34,900	61,535	Public	2,785	172	6	50	13
(12)	Broadcom	USA	3,668	5,233	Public	1,781	1,254	115	7	6
(13)	Unisys	USA	5,230	30,000	Public	1,737	194	67	26	13
(14)	Apple Computers	USA	24,000	21,600	Public	1,737	288	159	19	2
(15)	EMC	USA	11,200	31,100	Public	1,274	146	53	64	10
(16)	Lexmark	USA	5,108	14,900	Public	1,022	100	0	10	1
(17)	Dell	USA	57,400	82,200	Public	985	10	4	32	8
(18)	Imation	USA	1,584	2,070	Public	373	95	3	14	2
(19)	National Instruments	USA	661	4,199	Public	353	3	153	8	1
(20)	Diebold	USA	2,906	15,451	Public	215	67	1	25	2

TABLE A1:

PANEL E: TOP 10 INNOVATING CORPORATIONS - TELECOMMUNICATIONS

	Group name	Country of ultimate owner	Sales (M, $)	# of employees	Public	Patents USPTO	Patents EPO	Publications	# of subsidiaries	# of patenting subsidiaries
(1)	Siemens	Germany	110,820	427,000	Public	31,999	55,190	4,357	578	101
(2)	Motorola	USA	15,800	24,568	Public	17,639	5,359	2,462	76	23
(3)	Alcatel-Lucent	France	19,400	46,096	Public	8,567	7,272	3,659	138	43
(4)	AT&T	USA	63,100	302,770	Public	5,845	4,999	10	401	12
(5)	Nokia	Finland	44,800	56,896	Public	3,817	3,597	35	38	11
(6)	Ericsson	Sweden	2,385	56,055	Public	3,293	6,393	28	63	17
(7)	Harris Corp	USA	3,500	16,000	Public	1,948	591	3	63	8
(8)	Qualcomm	USA	11,142	15,400	Public	1,887	2,381	352	16	7
(9)	Vodafone	Great Britain	55,810	72,375	Public	1,408	1,186	0	5	1
(10)	BT Group	Great Britain	31,200	108,500	Public	1,074	1,849	213	242	4
(11)	France Telecom	France	33,900	67,784	Public	543	1,880	2	210	5
(12)	ADC Telecommunicatios	USA	1,322	9,050	Public	419	95	0	10	2
(13)	Verizon Communications	USA	88,100	24,200	Public	252	7	15	249	14
(14)	Teleflex	USA	2,647	19,800	Public	229	32	4	75	16
(15)	Qwest Communications	USA	13,900	38,000	Public	215	0	0	17	18
(16)	Deutsche Telekom	Germany	81,300	238,134	Public	171	798	2	231	6
(17)	Time Warner	USA	44,200	92,700	Public	155	47	15	314	20
(18)	3COM	USA	1,300	6,000	Public	155	7	2	15	2
(19)	Telefonica	Spain	50,700	19,508	Public	22	59	8	160	4
(20)	Telecom Italia	Italy	41,900	90,129	Public	17	318	2	73	2

TABLE A2:

ORGANIC VS. M&A BUSINESS-GROUP GROWTH

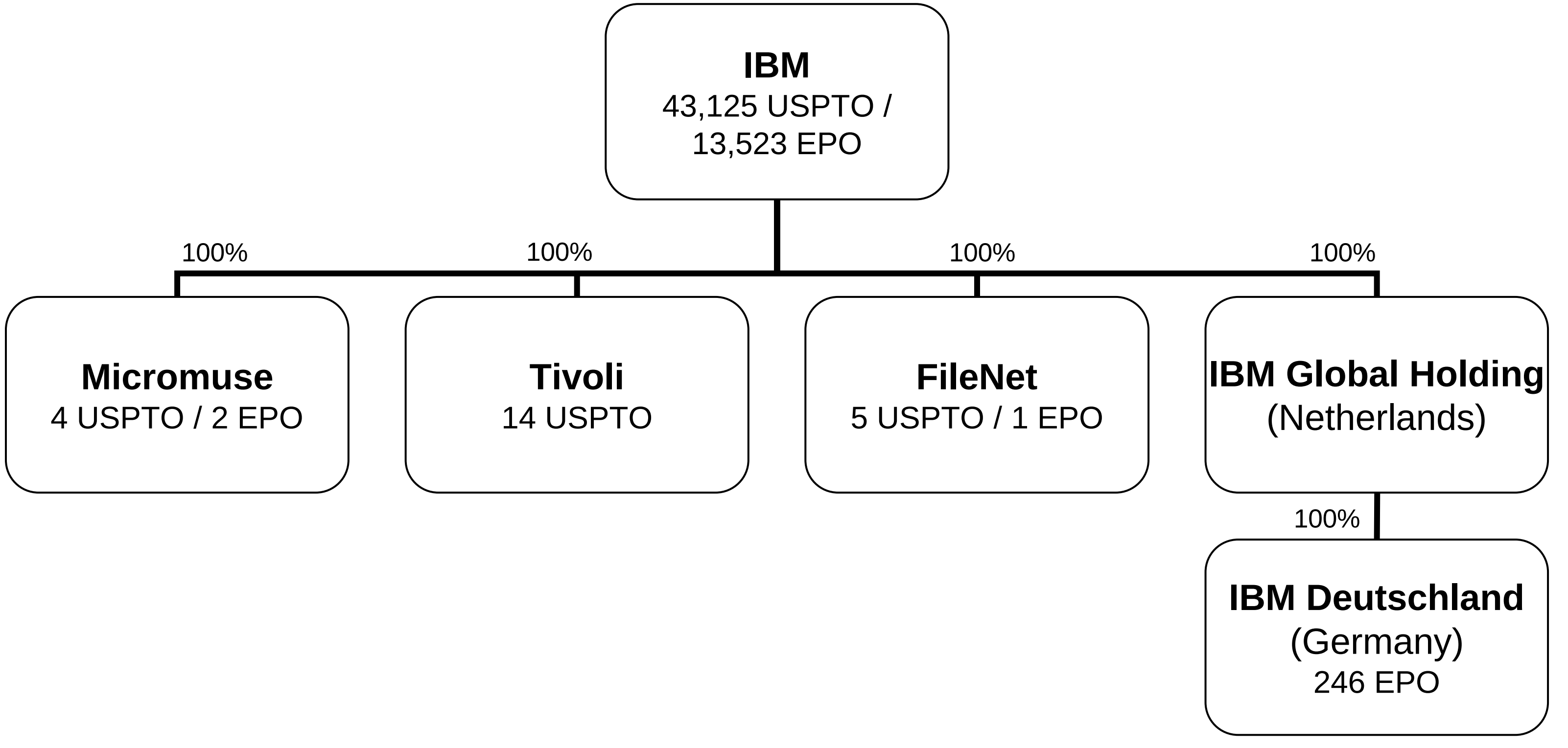
	Number of Subsidiaries			USPTO Patents			EPO Patents		
Ultimate Owner Country	Subs Joing by Organic Growth	Subs Joined by M&A	Total Group Affiliates	Subs Joing by Organic Growth	Subs Joined by M&A	Total Group Affiliates	Subs Joing by Organic Growth	Subs Joined by M&A	Total Group Affiliates
Austria	218 (91%)	21 (9%)	239	803 (76%)	247 (24%)	1,050	3,615 (91%)	337 (9%)	3,952
Belgium	298 (93%)	24 (7%)	322	3,886 (95%)	225 (5%)	4,111	4,874 (95%)	230 (5%)	5,104
Denmark	209 (92%)	18 (8%)	227	1,663 (92%)	143 (8%)	1,806	3,181 (98%)	51 (2%)	3,232
Finland	170 (88%)	24 (12%)	194	644 (94%)	43 (6%)	687	728 (90%)	79 (10%)	807
France	1,093 (90%)	122 (10%)	1,215	18,376 (75%)	6,132 (25%)	24,508	28,176 (78%)	7,799 (22%)	35,975
Germany	1,385 (92%)	118 (8%)	1,503	16,068 (89%)	1,990 (11%)	18,058	27,659 (93%)	2,226 (7%)	29,885
Great Britain	1,518 (91%)	142 (9%)	1,660	16,564 (96%)	722 (4%)	17,286	19,288 (79%)	5,025 (21%)	24,313
Greece	1 (25%)	3 (75%)	4	1 (25%)	3 (75%)	4	-	-	-
Italy	416 (92%)	38 (8%)	454	1,374 (87%)	200 (13%)	1,574	4,009 (85%)	720 (15%)	4,729
Netherlands	397 (91%)	39 (9%)	436	2,518 (96%)	117 (4%)	2,635	3,575 (92%)	298 (8%)	3,873
Norway	118 (92%)	10 (8%)	128	115 (60%)	76 (40%)	191	210 (78%)	59 (22%)	269
Republic of Ireland	34 (79%)	9 (21%)	43	144 (94%)	9 (6%)	153	174 (94%)	12 (6%)	186
Spain	115 (86%)	19 (14%)	134	254 (96%)	11 (4%)	265	462 (92%)	38 (8%)	500
Sweden	527 (91%)	53 (9%)	580	3,174 (90%)	347 (10%)	3,521	12,211 (97%)	403 (3%)	12,614
Switzerland	517 (92%)	45 (8%)	562	13,059 (83%)	2,592 (17%)	15,651	17,620 (99%)	170 (1%)	17,790
Total Europe	7,016 (91%)	*685* (9%)	*7,701*	*78,643* (86%)	*12,857* (14%)	*91,500*	*125,782* (88%)	*17,447* (12%)	*143,229*
United States	4,807 (90%)	522 (10%)	5,329	93,728 (95%)	4,978 (5%)	98,706	47,117 (92%)	4,083 (8%)	51,200
Total	11,823 (91%)	1,207 (9%)	13,030	172,371 (91%)	17,835 (9%)	190,206	172,899 (89%)	21,530 (11%)	194,429

TABLE A3:

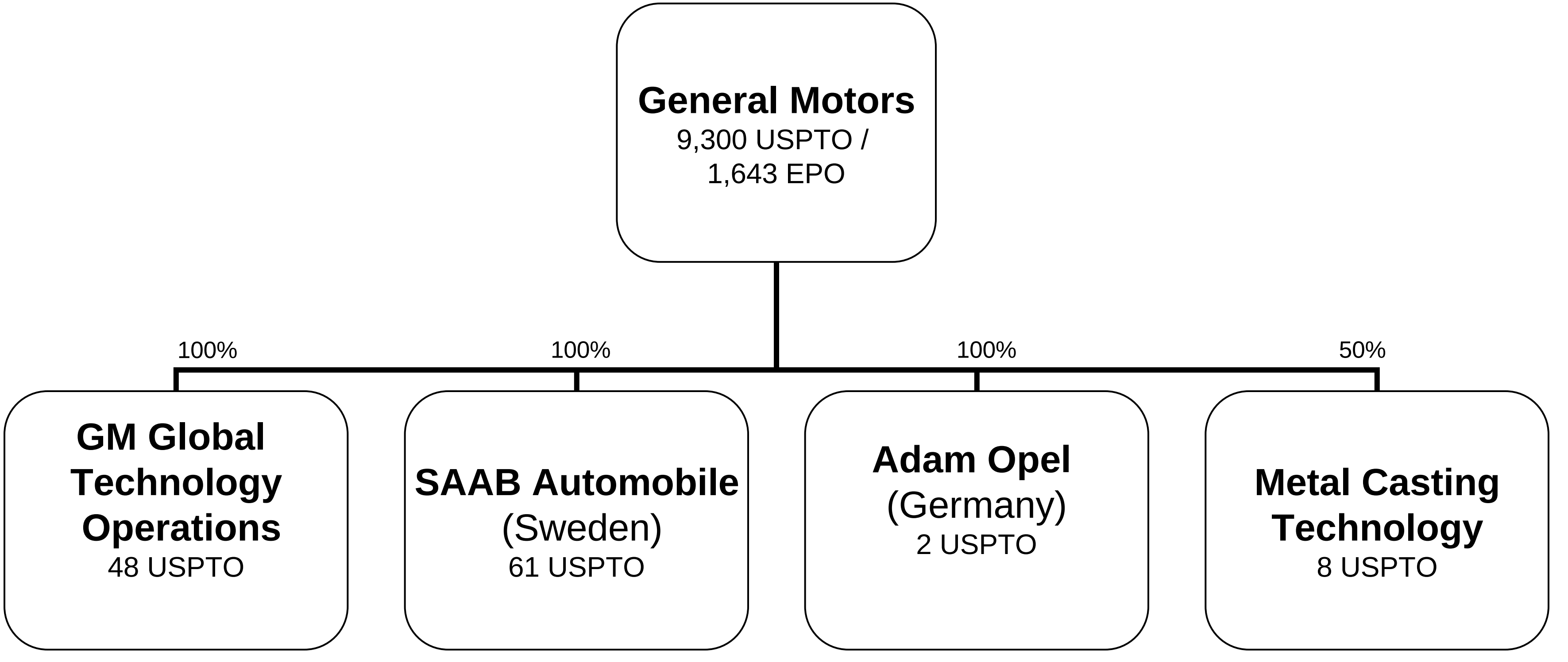
INNOVATION AND OWNERSHIP STRUCTURE ACROSS COUNTRIES: USPTO PATENTS GRANTED BETWEEN 1996 AND 2006

Ultimate Owner Country	Stand Alone	Conglomerate	Business Group			Total
			Total affiliates	*Wholly-owned*	*Minority Shareholders*	
Austria	324 (33%)	373 (38%)	295 (30%)	178 (18%)	117 (12%)	992
Belgium	161 (3%)	3,333 (66%)	1,524 (30%)	481 (10%)	1,043 (21%)	5,018
Denmark	240 (10%)	1,439 (59%)	763 (31%)	285 (12%)	478 (20%)	2,442
Finland	536 (11%)	4,166 (86%)	157 (3%)	123 (3%)	34 (1%)	4,859
France	511 (4%)	3,039 (21%)	10,992 (76%)	9,193 (63%)	1,799 (12%)	14,542
Germany	7,087 (15%)	35,379 (74%)	5,625 (12%)	1,998 (4%)	3,627 (8%)	48,091
Great Britain	1,708 (14%)	8,614 (71%)	1,893 (15%)	1,793 (15%)	100 (1%)	12,215
Greece	15 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	15
Italy	2,280 (62%)	812 (22%)	586 (16%)	168 (5%)	418 (11%)	3,678
Netherlands	166 (2%)	7,136 (92%)	455 (6%)	297 (4%)	158 (2%)	7,757
Norway	291 (62%)	117 (25%)	62 (13%)	44 (9%)	18 (4%)	470
Republic of Ireland	52 (24%)	44 (20%)	124 (56%)	117 (53%)	7 (3%)	220
Spain	222 (52%)	80 (19%)	129 (30%)	72 (17%)	57 (13%)	431
Sweden	420 (12%)	1,839 (52%)	1,272 (36%)	633 (18%)	639 (18%)	3,531
Switzerland	824 (7%)	6,956 (62%)	3,412 (30%)	774 (7%)	2,638 (24%)	11,192
Total Europe	*14,837* *(13%)*	*73,327* *(64%)*	*27,289* (24%)	*16,156* (14%)	*11,133* *(10%)*	*115,453*
United States	75,437 (20%)	280,464 (76%)	12,508 (3%)	10,468 (3%)	2,040 (1%)	368,409
Total	90,274 (19%)	353,791 (73%)	39,797 (8%)	26,624 (6%)	13,173 (3%)	483,862

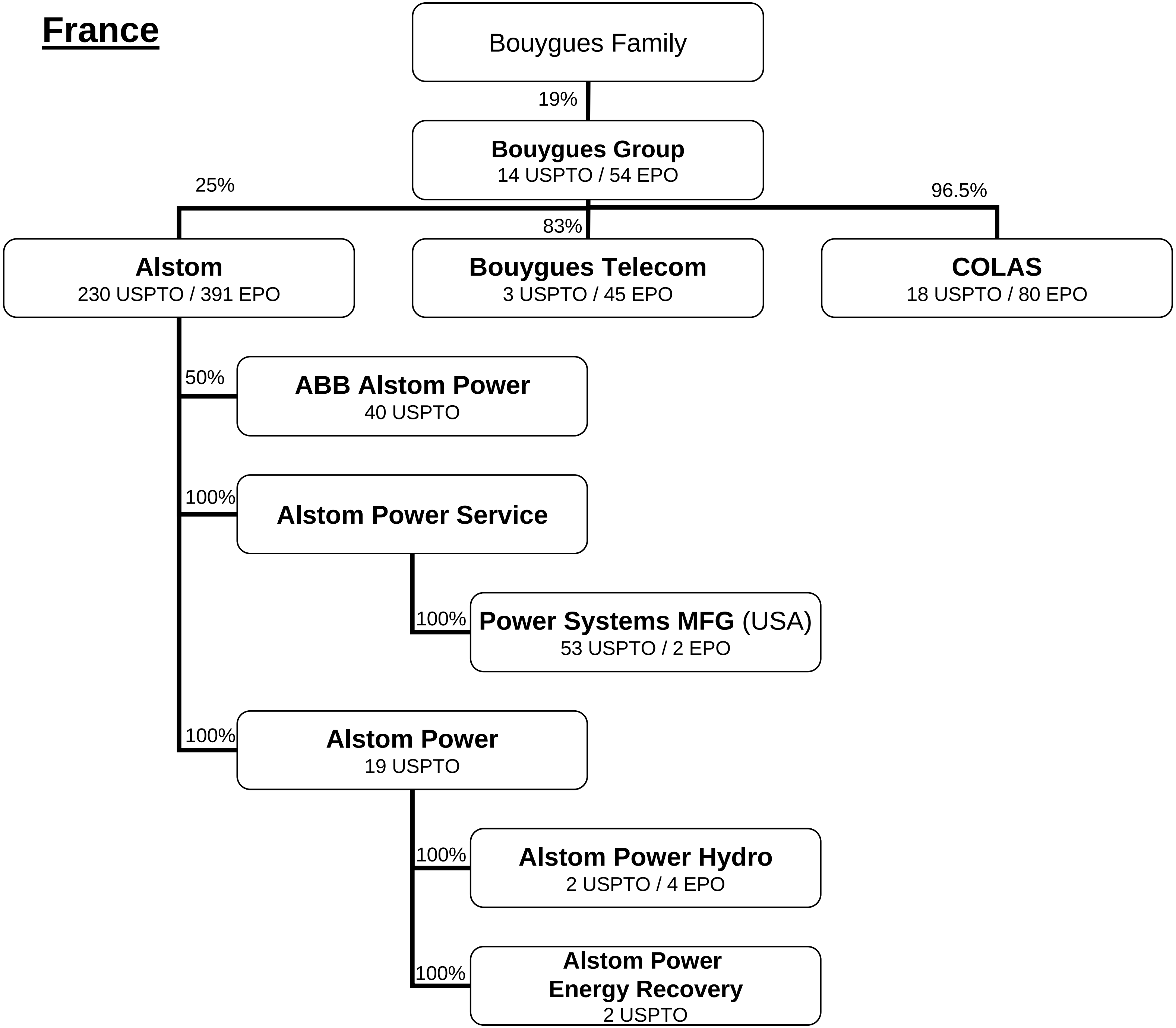
United States



United States

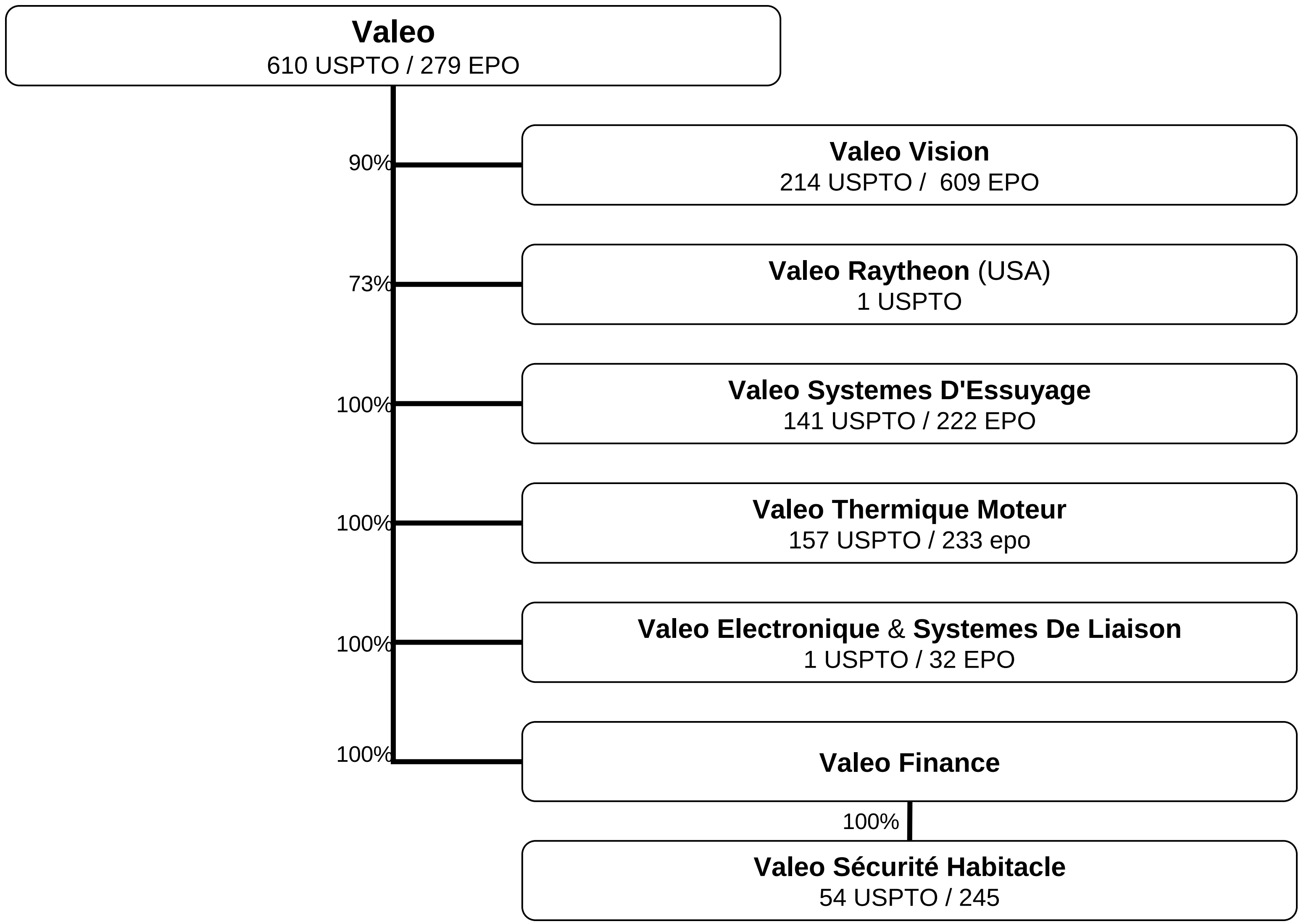


France

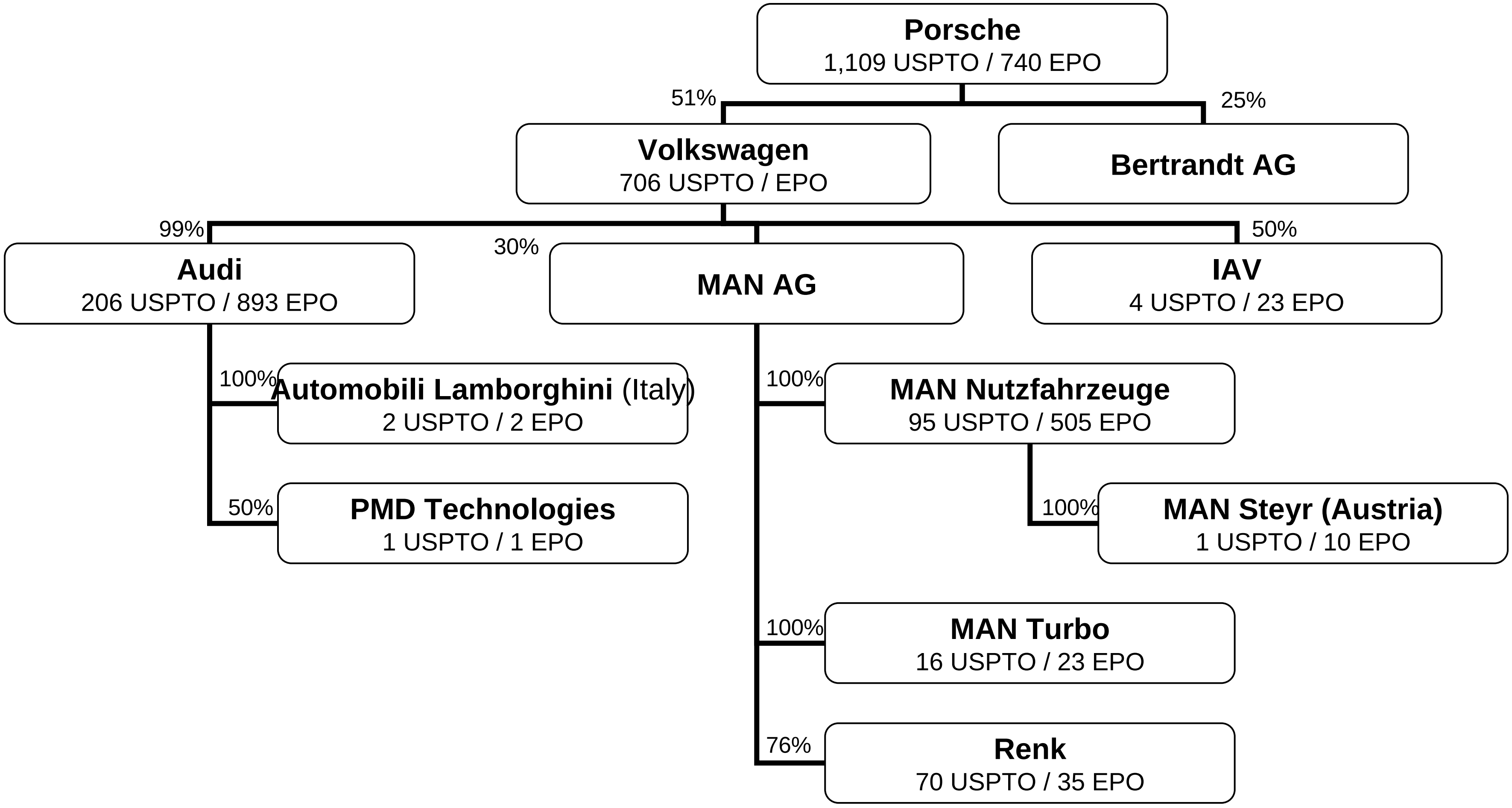


Bouygues Family
19%
Bouygues Group
14 USPTO / 54 EPO
25%
83%
96.5%
Alstom
230 USPTO / 391 EPO
Bouygues Telecom
3 USPTO / 45 EPO
COLAS
18 USPTO / 80 EPO
50%
ABB Alstom Power
40 USPTO
100%
Alstom Power Service
100%
Power Systems MFG (USA)
53 USPTO / 2 EPO
100%
Alstom Power
19 USPTO
100%
Alstom Power Hydro
2 USPTO / 4 EPO
100%
Alstom Power
Energy Recovery
2 USPTO

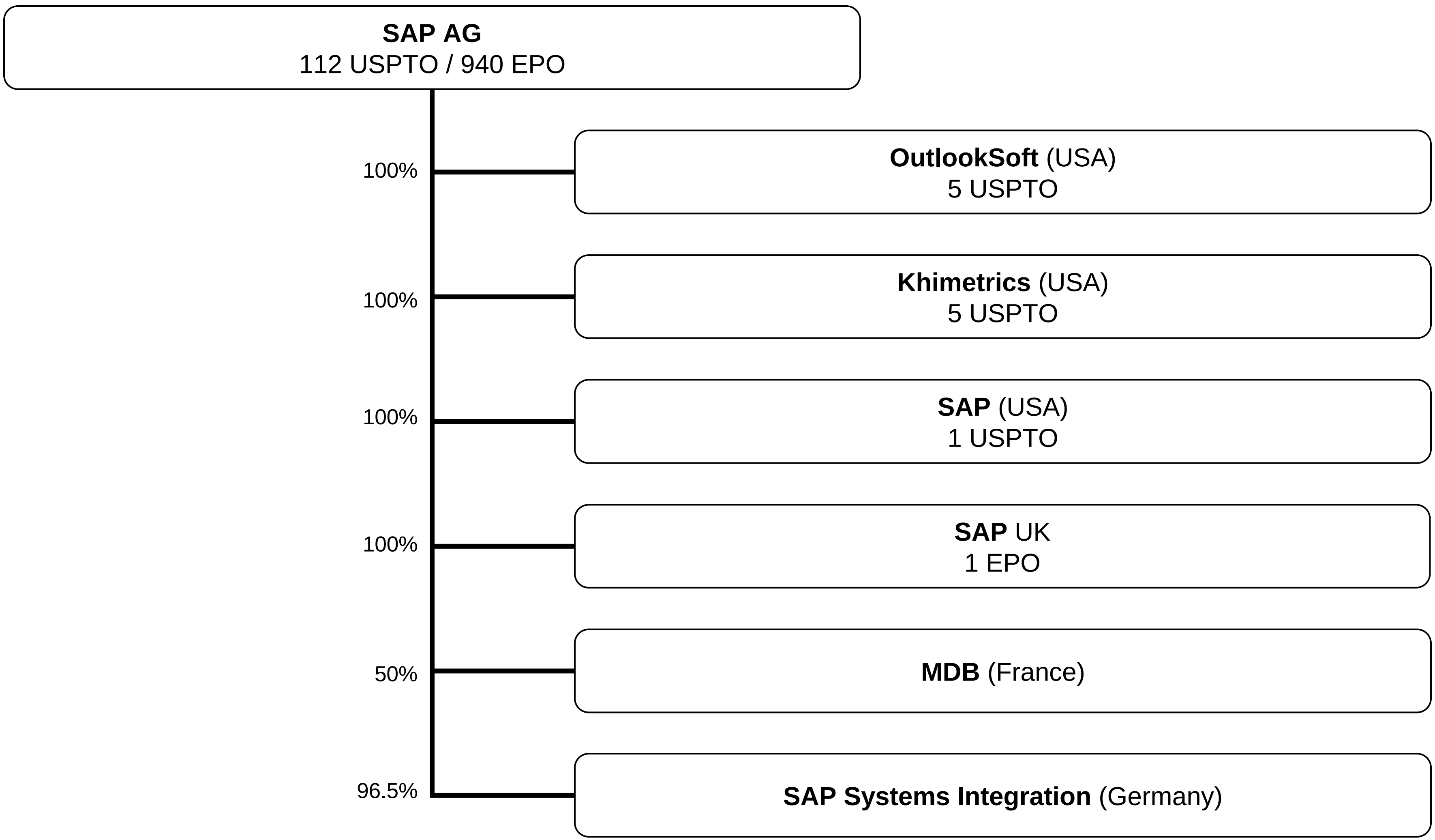
France


Valeo
610 USPTO / 279 EPO
90%
Valeo Vision
214 USPTO / 609 EPO
73%
Valeo Raytheon (USA)
1 USPTO
100%
Valeo Systemes D'Essuyage
141 USPTO / 222 EPO
100%
Valeo Thermique Moteur
157 USPTO / 233 epo
100%
Valeo Electronique & Systemes De Liaison
1 USPTO / 32 EPO
100%
Valeo Finance
100%
Valeo Sécurité Habitacle
54 USPTO / 245

Germany

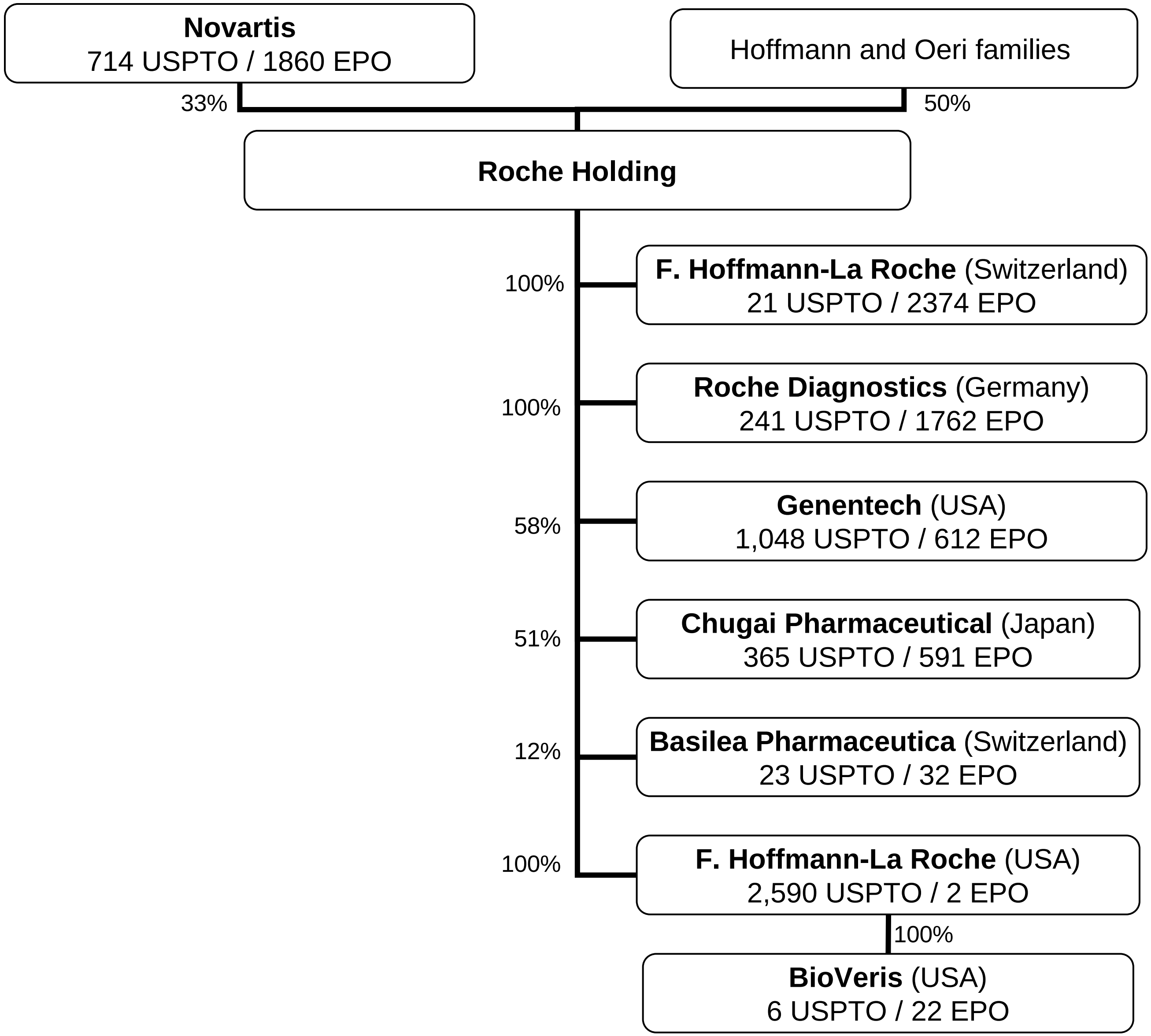

Porsche
1,109 USPTO / 740 EPO
51%
25%
Volkswagen
706 USPTO / EPO
Bertrandt AG
99%
30%
50%
Audi
206 USPTO / 893 EPO
MAN AG
IAV
4 USPTO / 23 EPO
100%
Automobili Lamborghini (Italy)
2 USPTO / 2 EPO
50%
PMD Technologies
1 USPTO / 1 EPO
100%
MAN Nutzfahrzeuge
95 USPTO / 505 EPO
100%
MAN Steyr (Austria)
1 USPTO / 10 EPO
100%
MAN Turbo
16 USPTO / 23 EPO
76%
Renk
70 USPTO / 35 EPO

Germany

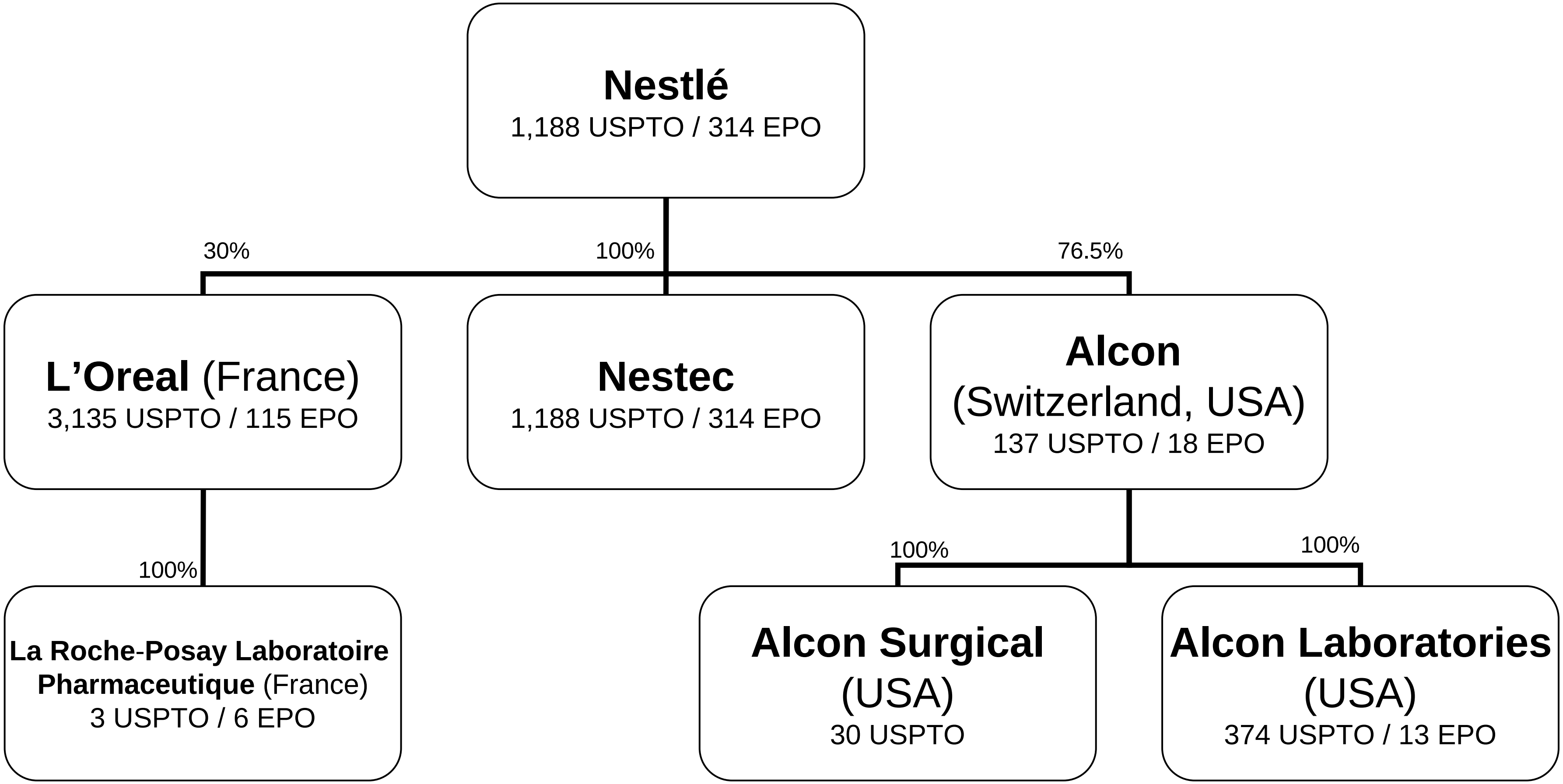


SAP AG
112 USPTO / 940 EPO
100%
OutlookSoft (USA)
5 USPTO
100%
Khimetrics (USA)
5 USPTO
100%
SAP (USA)
1 USPTO
100%
SAP UK
1 EPO
50%
MDB (France)
96.5%
SAP Systems Integration (Germany)

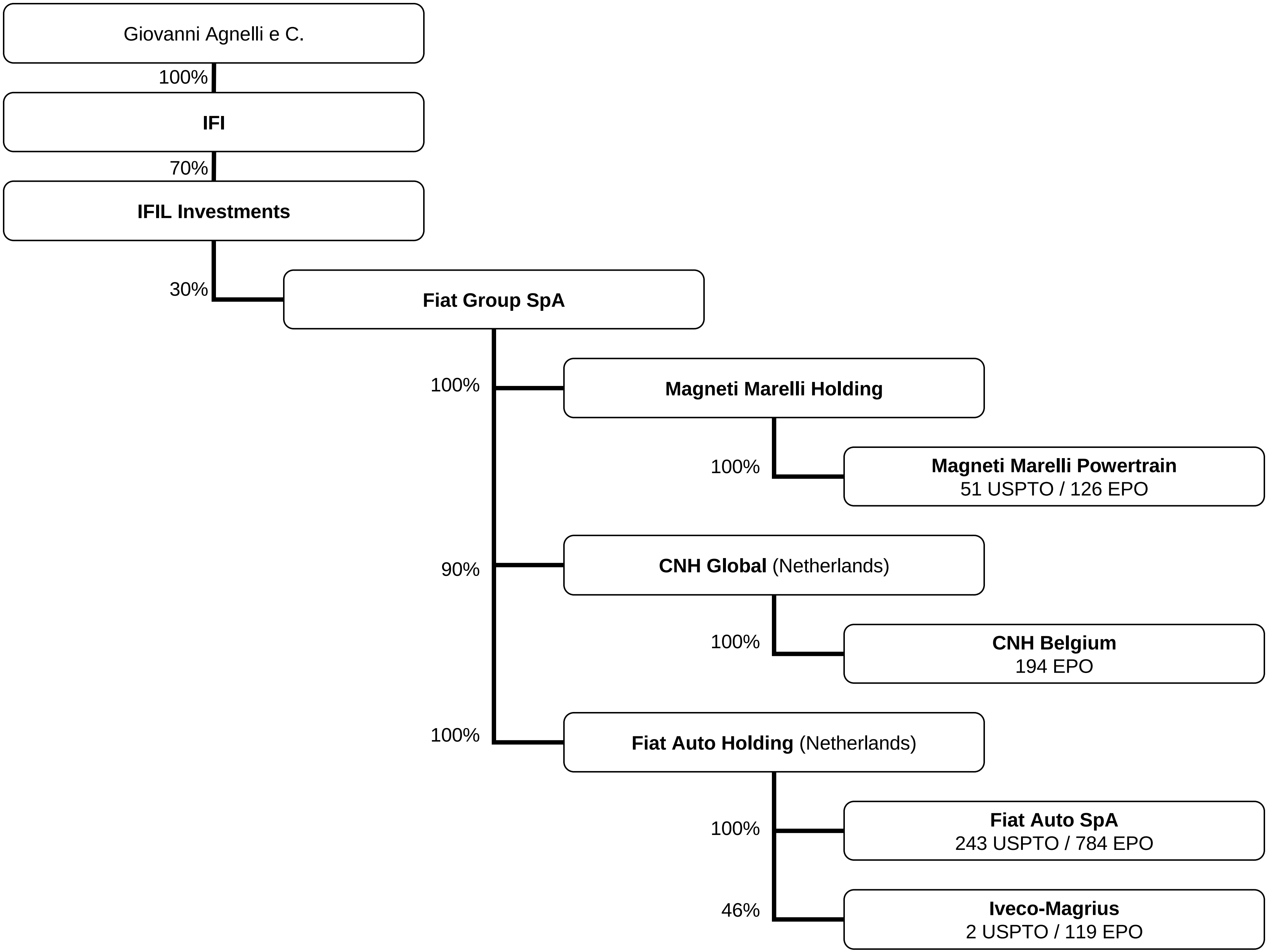
Switzerland



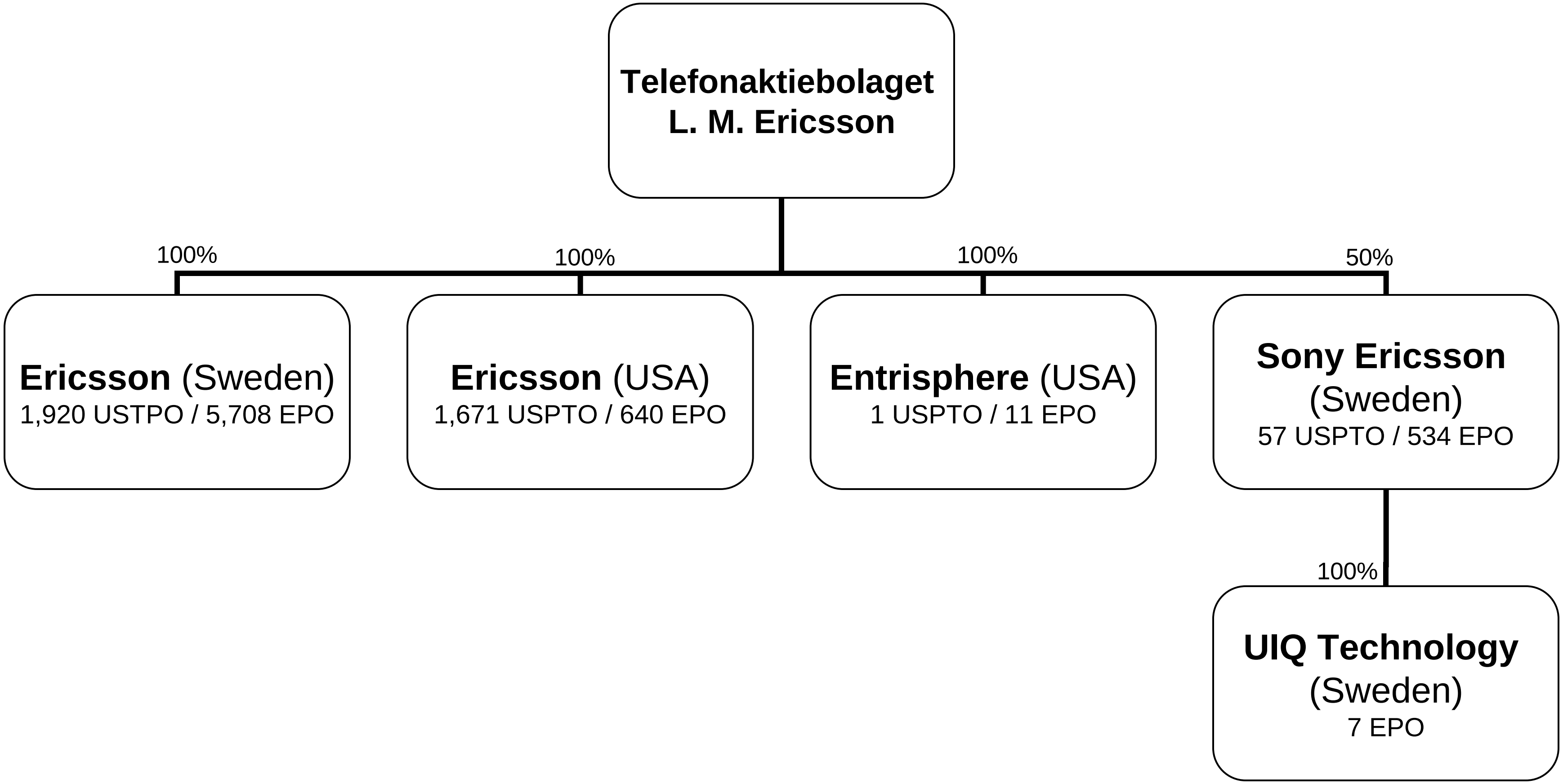
Switzerland



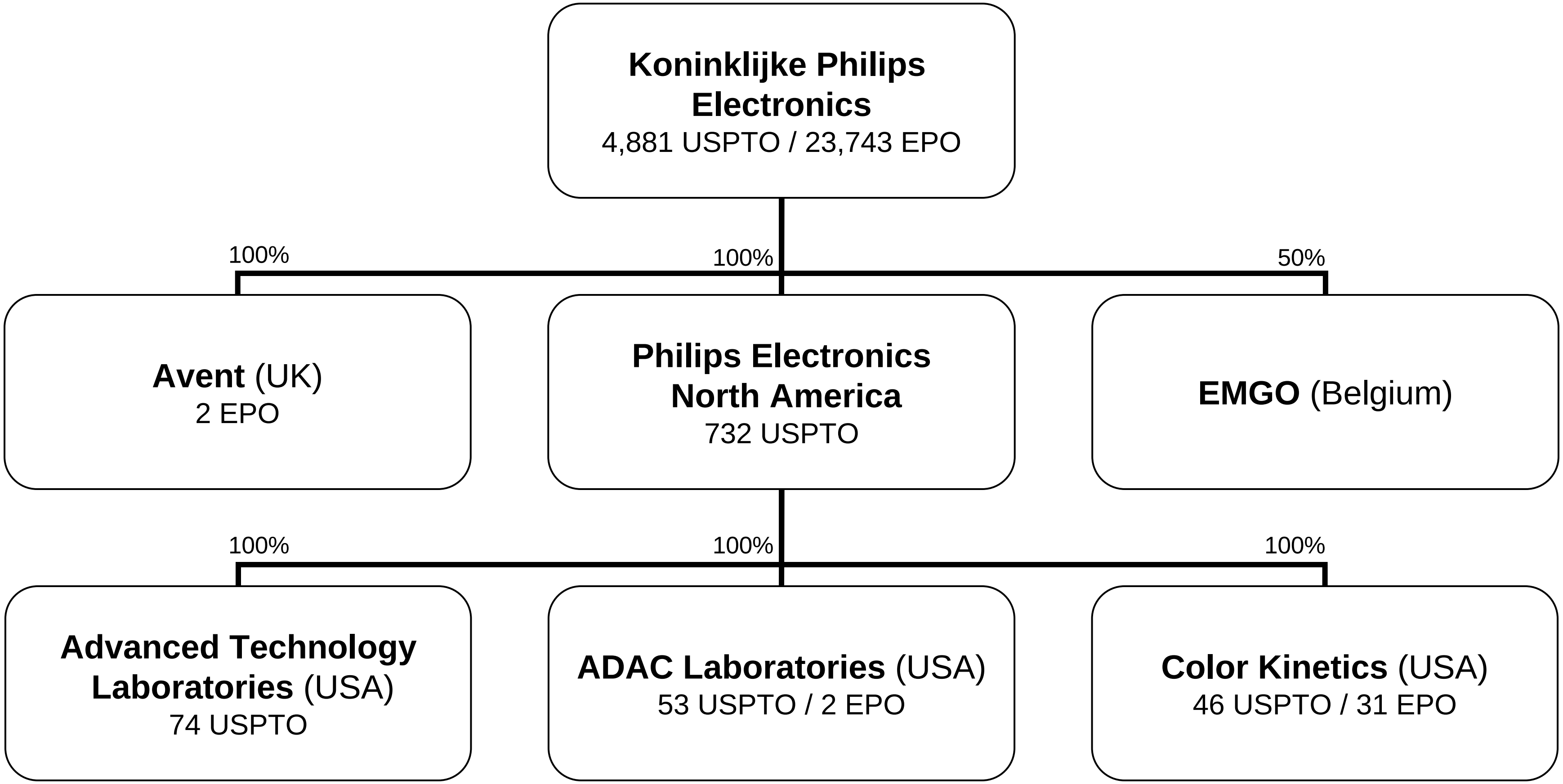
Italy


Giovanni Agnelli e C.
100%
IFI
70%
IFIL Investments
30%
Fiat Group SpA
100%
Magneti Marelli Holding
100%
Magneti Marelli Powertrain
51 USPTO / 126 EPO
90%
CNH Global (Netherlands)
100%
CNH Belgium
194 EPO
100%
Fiat Auto Holding (Netherlands)
100%
Fiat Auto SpA
243 USPTO / 784 EPO
46%
Iveco-Magrius
2 USPTO / 119 EPO

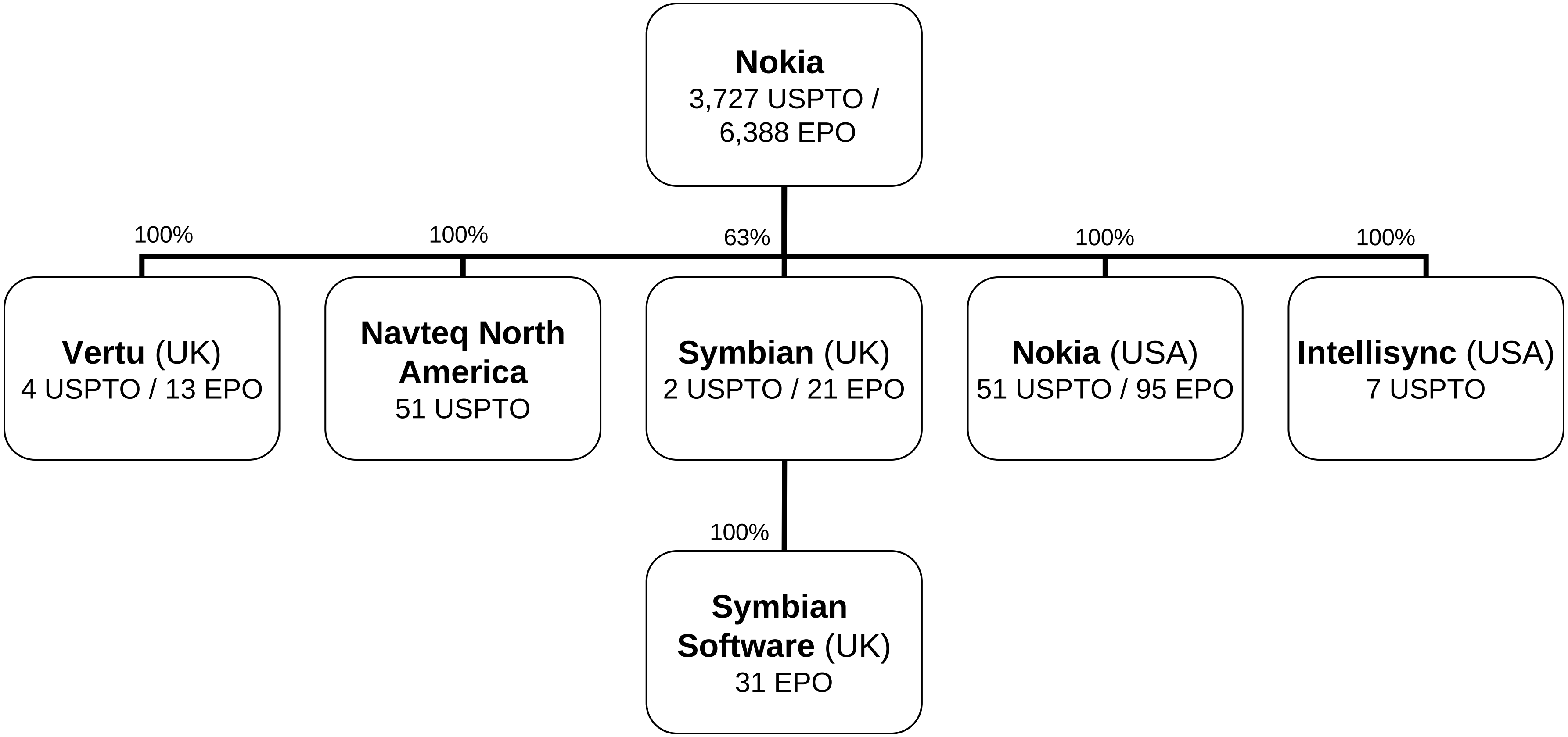
Sweden


Telefonaktiebolaget L. M. Ericsson
100%
100%
100%
50%
Ericsson (Sweden)
1,920 USTPO / 5,708 EPO
Ericsson (USA)
1,671 USPTO / 640 EPO
Entrisphere (USA)
1 USPTO / 11 EPO
Sony Ericsson (Sweden)
57 USPTO / 534 EPO
100%
UIQ Technology (Sweden)
7 EPO

Netherlands



Finland



Nokia
3,727 USPTO /
6,388 EPO
100%
100%
63%
100%
100%
Vertu (UK)
4 USPTO / 13 EPO
Navteq North America
51 USPTO
Symbian (UK)
2 USPTO / 21 EPO
Nokia (USA)
51 USPTO / 95 EPO
Intellisync (USA)
7 USPTO
100%
Symbian Software (UK)
31 EPO