

# ON REAL EFFECTS OF FINANCIAL SYNERGIES

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# Contents

- 1 Introduction** **7**
  
- 2 A Primer on Synergies** **16**
  - 2.1 Introduction . . . . . 16
  - 2.2 Basics of Diversifying Mergers . . . . . 18
    - 2.2.1 An Example . . . . . 18
    - 2.2.2 Incentives to Merge and Synergies . . . . . 19
    - 2.2.3 General Causes of Synergies . . . . . 21
  - 2.3 Causes of Operational Synergies . . . . . 23
    - 2.3.1 Excess Capacity . . . . . 23
    - 2.3.2 Internal (Capital) Markets . . . . . 26
    - 2.3.3 Anti-Competitive Strategies . . . . . 28
    - 2.3.4 Operational Costs of Risk . . . . . 30
  - 2.4 Causes of Financial Synergies . . . . . 31
    - 2.4.1 Limited Liability . . . . . 32
    - 2.4.2 Distress Costs . . . . . 33
    - 2.4.3 Corporate Taxation . . . . . 34
  - 2.5 Real Effects of Synergies . . . . . 35
  - 2.6 Stylized Facts . . . . . 38
  - 2.7 Summary . . . . . 40
  
- 3 The Model** **42**
  - 3.1 Introduction . . . . . 42
  - 3.2 A Diversifying Merger . . . . . 45
  - 3.3 An Alternative: Investment in R&D . . . . . 51
  - 3.4 Irrelevance . . . . . 55
  - 3.5 Summary . . . . . 56
  
- 4 Limited Liability** **57**
  - 4.1 Introduction . . . . . 57
  - 4.2 Output Distortions . . . . . 59

4.3	Real Effects of Financial Synergies . . . . .	63
4.4	Applications and Extensions . . . . .	68
4.4.1	Structured Finance and the Financial Crisis . . . . .	69
4.4.2	Strategic Costs of Diversification . . . . .	70
4.4.3	Strategic Debt . . . . .	71
4.4.4	Investment in R&D . . . . .	72
4.4.5	Internalizing the Externality . . . . .	74
4.5	Summary . . . . .	76
4.6	Proofs . . . . .	77
4.7	Conditional Expectations . . . . .	79
<b>5</b>	<b>Distress Costs</b>	<b>81</b>
5.1	Introduction . . . . .	81
5.2	Output Distortions . . . . .	83
5.3	Real Effects of Financial Synergies . . . . .	88
5.4	Applications and Extensions . . . . .	93
5.4.1	Incremental Mergers and Myopic Competition Policy . . . . .	93
5.4.2	Asymmetric Mergers . . . . .	95
5.4.3	Optimal Horizontal Boundaries . . . . .	97
5.4.4	Proportional Distress Costs . . . . .	99
5.4.5	General Distress Triggers . . . . .	101
5.5	Summary . . . . .	101
5.6	Proofs . . . . .	102
<b>6</b>	<b>Asymmetric Corporate Taxation</b>	<b>105</b>
6.1	Introduction . . . . .	105
6.2	Output Distortions . . . . .	108
6.3	Real Effects of Financial Synergies . . . . .	112
6.4	Applications and Extensions . . . . .	116
6.4.1	Lump-Sum Taxation . . . . .	116
6.4.2	Strategic Benefits of Diversification . . . . .	117
6.4.3	General Uncertainty . . . . .	119
6.5	Summary . . . . .	121
6.6	Proofs . . . . .	121
<b>7</b>	<b>Conclusions</b>	<b>124</b>
	<b>Bibliography</b>	<b>128</b>

# List of Figures

1.1	Two Trade Routes of Venetian Sea Merchants in the Mediterranean Sea . . . . .	9
2.1	M&A Activity in Germany in Years 1995 to 2008 . . . . .	39
3.1	Optimal Quantities in the Merger Model . . . . .	48
3.2	Timing in the Merger Model . . . . .	50
3.3	Optimal Investment in the R&D Model . . . . .	54
3.4	Timing in the R&D Model . . . . .	55
4.1	Valuation Functions with Unlimited and Limited Liability . . . . .	58
4.2	Example of Financial Synergies and Quantity Effects with Limited Liability . . . . .	67
5.1	Valuation Functions with Zero and Positive Distress Costs . . . . .	83
5.2	Market Value, Output and the Riskiness of Cash Flow . . . . .	87
5.3	Example of Financial Synergies and Quantity Effects with Distress Costs . . . . .	91
5.4	Incremental Mergers and the Propagation of Asymmetric Shocks . . . . .	94
5.5	Possible Configurations of Horizontal Boundaries . . . . .	98
6.1	Valuation Functions with Symmetric and Asymmetric Corporate Taxation . . . . .	108
6.2	Tax Tariffs, Expected Tax Revenue and Output Distortions . . . . .	111
6.3	Example of Financial Synergies and Quantity Effects with Asymmetric Proportional Taxation . . . . .	114
6.4	Example of Financial Synergies and Quantity Effects with Asymmetric Lump-Sum Taxation . . . . .	117
7.1	Example of Financial Synergies and Quantity Effects in Leland (2007) . . . . .	126

# List of Tables

- 2.1 Specific Causes of Operational and Financial Synergies . . . . . 24
- 2.2 Example of Asset Values . . . . . 32
- 2.3 Market Values and Financial Synergies with Limited Liability . . . . . 33
- 2.4 Combinations of Synergies and Quantity Effects . . . . . 36
  
- 5.1 Example of Optimal Horizontal Boundaries . . . . . 99
  
- 6.1 Tax Tariffs in Selected Countries . . . . . 106
- 6.3 Summary of Financial Synergies and Quantity Effects with Asymmetric  
Proportional Taxation . . . . . 113
  
- 7.1 Different Combinations of Synergies and Quantity Effects . . . . . 124

# Chapter 1

## Introduction

*My ventures are not in one bottom trusted,  
Nor to one place; nor is my whole estate  
Upon the fortune of this present year:  
Therefore my merchandise makes me not sad.*

— Antonio in Shakespeare's Merchant of Venice

On April 28th 2008, Mars Inc, a family-owned US producer of chocolate confectionary who is well-known for household brands like Snickers and M&Ms, announced the acquisition of the Wrigley Company, an international chewing-gum behemoth listed on the New York Stock Exchange and famous all over the world for sticky brands like Orbit and Doublemint. According to an official press-release, the transaction was valued at approximately US\$ 23 billion and supposed to benefit Mars by „diversifying its confectionary business”.<sup>1</sup> The price tag was hefty: Mars paid a 34% take-over premium to Wrigley's former owners. Yet the deal was welcomed by media and investment analysts alike, as it was hailed to bring „together two companies with many similarities and a complementary portfolio of products” and to exert „pressure on competitors like Hershey, Cadbury Schweppes and Nestlé to make deals of their own to compete with a bigger Mars”.<sup>2</sup>

Competition authorities, who are supposed to protect consumers from harmful mergers and acquisitions, were apparently not very concerned about the transaction. There is no evidence that either the US Federal Trade Commission or the US Department of Justice had significant objections. Similarly, the European merger authority, the EU Directorate General Competition (DGC), smoothly cleared the deal on July 28th of the same year, concluding „the proposed transaction would not significantly impede effective competition in the European Economic Area”.<sup>3</sup>

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<sup>1</sup>Full text of the press-release available at <http://www.mars.com>.

<sup>2</sup>„Mars Offers \$23 Billion Cash for Wrigley”, *The New York Times*, April 29th 2008.

<sup>3</sup>Official press-release of the DGC with reference IP/08/1215, available at <http://europa.eu/rapid>.

The disclosed original assessment of the case by the DGC reveals the reasoning behind the transaction's clearing.<sup>4</sup> It argues that chocolate and chewing-gum are neither close substitutes nor significant complements, consequently horizontal effects and anti-competitive practices like bundling or tying were deemed implausible. So were vertical effects, since Mars and Wrigley are obviously not in a customer-supplier relationship. Quite naturally, since firms were unrelated, the acquisition was therefore not expected to impede competition or to harm consumers. Indeed, consumers could only benefit from possible efficiency gains, for example, from cost savings in sales, distribution and marketing that materialize in lower prices of chocolate or bubble-gum.

This assessment is characteristic for the analysis of diversifying transactions, that is, of corporate diversification. From the perspective of competition authorities most concentrations boil down to a trade-off between redistributive effects and efficiency gains, where the former harm and the latter benefit consumers. A transaction should be blocked only if harms are expected to outweigh gains. Traditional economic wisdom holds that redistributive effects of diversifying mergers are quite unlikely, compared with horizontal or vertical transactions that relax competitive constraints on firms. This explains why most competition authorities are not very concerned with corporate diversification and instead focus their scrutiny on horizontal and vertical transactions.<sup>5</sup> For example, it is official European policy that corporate diversification „in the majority of circumstances will not lead to any competition problems“.<sup>6</sup>

This thesis challenges the relaxed attitude of competition authorities towards corporate diversification. Examining a theoretical diversifying merger of firms in completely unrelated product markets, it finds that endogenous financial synergies caused by diversification have significant real effects on output of merging firms that can harm consumers. The following example, inspired by Shakespeare's *Merchant of Venice*, introduces the notion of financial synergies and associated real effects.

Poor Antonio, a sea merchant in late-medieval Venice, raises and invests funds in ships — the bottoms in the quoted verses at the beginning of this chapter — he sends abroad to buy merchandise sold in Venice upon return with a substantial margin. Antonio's business, an ancestor of a modern venture capital fund, was a hazardous affair. Ships got caught in storms or were marauded by pirates, often they never returned to Venice. For the sake of concreteness, assume Antonio has raised enough capital

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<sup>4</sup>The original full-text of the assessment is available as document No 32008M5188 at <http://eur-lex.europa.eu/>.

<sup>5</sup>A recent discussion paper of the German Federal Cartel Office reviews US, European and German authorities' policies/decisions on diversifying transactions. It finds an overall very permissive attitude, although European policies have become more sophisticated recently. See discussion paper „Konglomerate Zusammenschlüsse in der Fusionskontrolle - Bestandsaufnahme und Ausblick“, available at <http://www.bundeskartellamt.de>.

<sup>6</sup>Article 92 in „Guidelines on the Assessment of Non-Horizontal Mergers Under the Council Regulation on the Control of Concentrations Between Undertakings“, available at <http://ec.europa.eu/competition/>.



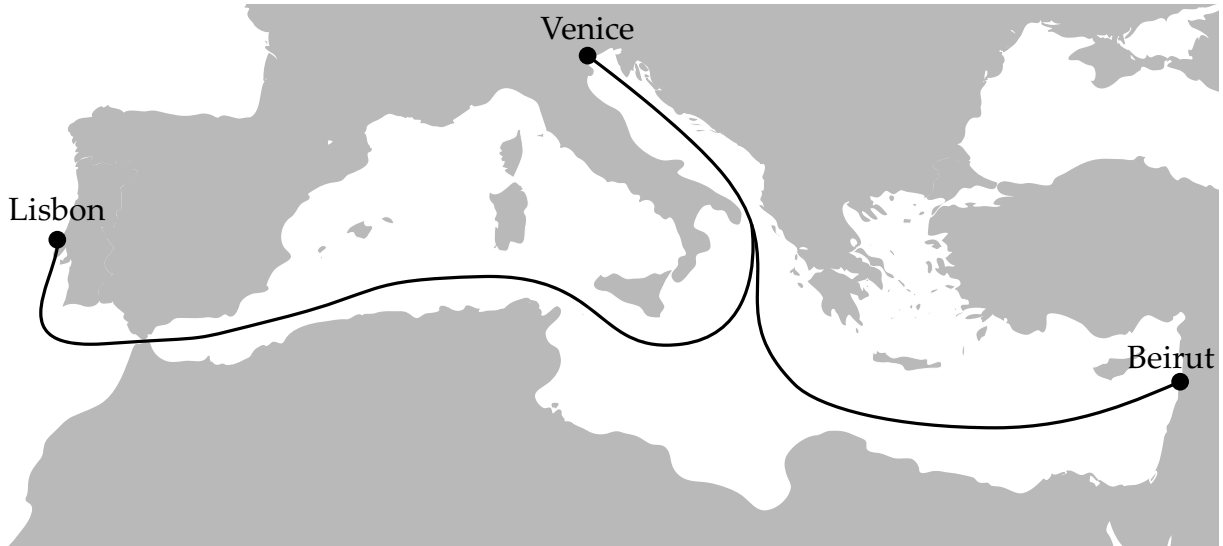


Figure 1.1: Two Trade Routes of Venetian Sea Merchants in the Mediterranean Sea

to finance two ships, and Lisbon and Beirut are the only feasible trade destinations, depicted on the map of the Mediterranean Sea in figure 1.1. Assume further that departing from Venice, round-trip journeys to both Lisbon and Beirut require an equal amount of capital, merchandise bought in either place will yield approximately the same total revenue back in Venice, and both journeys exhibit similar distances and risks. The weather on the route to Lisbon is usually favorable, but with probability 0.5 ships are attacked by pirates. On the other hand, there are no pirates on the trip to Beirut, but with probability 0.5 there is a disastrous storm. Antonio faces a simple choice between corporate specialization and diversification: either he sends both ships to the same destination (corporate specialization), or he sends one ship to Lisbon and the other one to Beirut (corporate diversification). The expected value of each vessel is not affected by this choice between specialization and diversification, that is, there are no operational synergies.<sup>7</sup> Yet the quoted verses above suggest Antonio prefers to diversify.

This preference for diversification results from a financial synergy. In Shakespeare's original play, Antonio's medieval investors are brutal and merciless, quite unlike today's highly civilized financial intermediaries. Whereas return of at least one ship allows Antonio to barely avert bankruptcy, he is bankrupt in the extreme event that no ship returns and consequently unable to pay his investors, in which case they are entitled to one pound of Antonio's living body (!) as compensation for their lost funds. In modern corporate finance terminology, this atrocity can be interpreted as a bankruptcy cost, that is, a financial cost triggered by the event of bankruptcy. Given this brutal

<sup>7</sup>Explicitly, assume a round-trip to either destination costs  $C$ , including merchandise acquired abroad. Expected revenue from sales of merchandise in Venice is  $R > C$ . The value of each ship is therefore either  $R - C$  (ship returns) or  $-C$  (ship does not return) with equal probability. Corporate specialization or diversification has then no effect on a ship's expected value.

financing arrangement, diversification is clearly the superior alternative. To see this, realize that with specialization only two outcomes are possible, irrespective of whether both ships travel to Beirut or Lisbon: either both ships return, or no ship returns. The probability of each event and therefore the probability of bankruptcy are 0.5. Diversification in turn allows for four different outcomes: both ships return, no ship returns, the ship from Beirut returns while the ship to Lisbon vanishes, and the ship to Lisbon returns while the ship to Beirut sinks. Each outcome has the same probability of 0.25. Since only one of these outcomes (no ship returns) involves bankruptcy of Antonio's business, the probability of bankruptcy is only 0.25 if he chooses to diversify.<sup>8</sup> The expected value of bankruptcy costs, the monetary value of his „expected pain“, is thus only half as high with diversification. This is called a financial synergy: even in the absence of operational synergies owners choose to diversify because their business is then more valuable than with specialization.

Such financial synergies have real effects if they affect the way in which Antonio manages and conducts his merchant business, that is, if they affect his real behavior or business strategy. For example, if Antonio chooses to diversify and is consequently less anxious about bankruptcy, he might be willing to buy greater quantities of merchandise abroad, and higher quantities imply that customers in Venice should benefit from lower prices. If quantities of merchandise are higher with corporate diversification than with specialization, then a purely financial synergy has a positive real (quantity) effect. In the realm of competition law these are the unilateral effects of a merger or an acquisition.

The initially mentioned Mars-Wrigley case might involve similar financial synergies and associated real effects, albeit of a more negative sort. About 50% of the US\$ 23 billion transaction was financed with debt, including a US\$ 5.7 billion senior debt facility supplied by investment bank Goldman Sachs and US\$ 4.4 billion of subordinated debt from Warren Buffett's Berkshire Hathaway Inc.<sup>9</sup> Wrigley's outstanding debt increased tenfold from US\$ 1.2 billion at the beginning of 2008 to nearly US\$ 12 billion at year's end, and its credit quality deteriorated substantially in the process. Standard & Poors downgraded Wrigley's credit rating from A+ (investment grade) to BB+ (speculative junk). In other words, Wrigley's probability of bankruptcy increased significantly because of the highly leveraged nature of the acquisition. This negative financial synergy could affect Wrigley's product market behavior. For example, if the higher likelihood of bankruptcy demands a more aggressive product market strategy that quickly generates high cash flows to pay principal and interest on debt (Jensen, 1986), this might force Wrigley to engage in a price-war, which would suggest that

<sup>8</sup>Technically, this conclusion rests on the assumption that pirate attacks on the route to Lisbon and storms on the route to Beirut are independent events, which is quite reasonable.

<sup>9</sup>„Wrigley's ratings may be cut on Mars deal“, *Reuters*, April 29th 2008, available at <http://www.reuters.com/article/idUSN287271820080429>.

consumers benefit from lower prices. Understanding the nature of such real effects is obviously decisive for the proper conduct of competition policy, as ignorance implies that some mergers are permitted which should rather be blocked, and vice versa.

Yet real effects of financial synergies have been ignored not only by competition authorities, but by industrial and financial economists as well. This neglect results most likely from division of labor. Classical separation and irrelevance theorems claim that left and right hand sides of firms' balance sheets can be examined separately (Fisher, 1930; Modigliani and Miller, 1958, 1963). Consequently, the literature on industrial economics long focused only on the left hand side of balance sheets and ignored the financing of firms. The corporate finance literature in turn revolved around the financing of assets, ignoring how the value of assets is related to the product market behavior of firms. In other words, each literature long ignored what was essential in the other.

The paradigm shift initiated by Jensen and Meckling (1976) sparked a wealth of research on the interaction between a firm's financial constitution and its real product market behavior. Although this literature is still relatively nascent, it points to several links that connect real and financial spheres of firms. Loosely speaking, this thesis is a „natural merger“ of selected seminal contributions to this literature and the literature on financial synergies. Such a merger is natural because both literatures ultimately revolve around the same three features of the financial constitution of firms, namely *limited liability*, *distress cost* and *corporate taxation*. All three features have been shown to cause financial synergies, and all three are known to have systematic implications for a firm's product market behavior. From this „merger of theories“ in this thesis emerges a rich picture of financial synergies and associated real effects, with interesting implications for competition policy.

The core result is that purely financial synergies may harm consumers. Seemingly innocuous financial aspects of mergers and acquisitions that cause such synergies are therefore potentially important for the assessment of unilateral effects by competition authorities. In other words, endogenous financial synergies can establish a case for policy intervention. The structure of the analysis and its most important results can be summarized as follows.

Chapter 2 is a primer on synergies in the context of corporate diversification that sets the stage for the analysis. Using the example of a diversifying merger of two firms in unrelated markets, it establishes definitions of operational and financial synergies, demonstrates how such synergies summon incentives to merge, and surveys the theoretical literature on causes and real effects of synergies in the context of corporate diversification. Overall, causes of both operational and financial synergies are well understood in theory. Operational synergies arise because of scope economies, internal capital markets, anti-competitive practices and operational cost of risk, while the most important causes for financial synergies are limited liability, distress costs and corpo-

rate taxation. The primer's main finding is that research on real effects of synergies is heavily skewed towards operational synergies, while real effects of financial synergies are a „white spot“ in the literature.

Chapter 3 presents the merger model used to examine different purely financial synergies and associated real effects in following chapters. Endogenous synergies arise from a diversifying merger of an arbitrary number of risk-neutral quantity-setting monopolists who exhibit normally distributed cash flows and operate in unrelated product markets, a natural extension of the example introduced in chapter 2. The most distinctive feature of this model is its simplicity: a single period, strict risk-neutrality, symmetric information, no agency-problems, and observable cash-flows. Comparison of total expected market values and output choices of firms before and after the merger allows examining the impact of financial synergies on consumers, firm owners and other stakeholders like tax authorities or suppliers. From a policy perspective, the central question is whether preferences of firm owners and consumers over the merger are aligned, as unaligned preferences can establish a case for merger regulation. Since the model is used to study several different characteristic properties of firms' financial constitutions that cause financial synergies, chapter 3 focuses only on the real sphere of firms. Each of the following three chapters then focuses on a single cause for financial synergies and examines associated real effects.

Chapter 4 examines financial synergies caused by limited liability and introduces the basic approach to the analysis of the merger model. Limited liability implies that firm owners are not liable for more than what they invest in a corporation. This limitation of liability allows owners to externalize losses of their business, so that firms with limited liability choose riskier product market strategies than firms with unlimited liability. A merger reduces the amount of losses that can be externalized, so financial synergies are negative, that is, the merger reduces the market value of firms. The first novel insight of this thesis is that such negative financial synergies have real quantity effects, as output is strictly lower if firms merge. Applications and extensions show how the combination of limited liability and corporate diversification can explain several stylized empirical facts, for example, the observation that diversified firms invest less in R&D, achieve smaller market shares and choose to hold more debt in their capital structure. Overall, with limited liability preferences of firm owners and consumers over the merger are aligned: both owners and consumers suffer if firms merge, and financial synergies caused by limited liability are no justification for competition policy.

Chapter 5 examines the second cause for financial synergies, costs of distress, that is, costs that arise if the value of a firm's assets falls below a threshold that triggers corporate distress, just like in the aforementioned example of Antonio's leveraged merchant business. Such costs motivate firms to behave cautiously in the product market to avert distress. Distress costs therefore not only have a negative direct impact on firm

owners, but possibly an indirect negative impact on consumers as well. Since total expected costs of distress are strictly smaller with diversification than with specialization, firm owners have incentives to merge because of a positive financial synergy. Yet, whereas incentives to merge depend on the cumulative probability of distress that is strictly lower after the merger, real quantity effects depend on marginal distress cost that may rise or fall. In other words, output may decrease if firms merge. Preferences of consumers and firm owners over diversification are therefore not necessarily aligned: if the merged firm produces less output than focused firms, then consumers suffer from a conglomerate merger and there is a rationale for merger regulation. Applications and extensions show some surprising implications of these results. For example, myopic competition authorities will block mergers that are intermediate steps towards an optimal allocation of assets. Moreover, the analysis has interesting implications for asymmetric cross-border mergers as well, since a low-risk domestic firm that acquires a high-risk foreign business can extract consumer surplus from the foreign country.

Chapter 6 investigates asymmetric corporate taxation, which is the third and final cause for financial synergies examined in this volume. Asymmetric taxation means that a firm's profits and losses are treated differently by tax authorities. Such asymmetric tax tariffs induce an output distortion that depends on whether the tariff involves over- or under-compensation for losses. Empirically relevant under-compensation implies a negative output distortion and positive financial synergies, as the total expected tax payment of the merged firm is always smaller than the total expected tax payment of stand-alone firms before the merger. A merger motivated by such financial synergies has positive real quantity effects, so preferences of firm owners and consumers are aligned. Again these results have interesting policy implications, for example, they point to a conflict between competition and tax authorities. Extensions examine lump-sum tariffs, extend findings to more general stochastic assumptions and demonstrate possible strategic benefits of corporate diversification in settings where firms compete in quantities.

Chapter 7 discusses implications and extensions of the analysis. Generally, results reveal a plethora of possible real effects caused by purely financial synergies. Even in quite unsophisticated settings such real effects can establish a rationale for competition policy, as seemingly harmless endogenous mergers of completely unrelated firms may harm consumers. A unified model of financial synergies with richer assumptions about the capital structure of firms is among the most promising extensions of this thesis. To examine possible implications of such an extension, an ad hoc product market is introduced into the optimal capital structure model of Leland (2007), where firms choose the optimal mix of equity and debt in the presence of limited liability, bankruptcy costs and asymmetric corporate taxation. Other promising extensions could examine financial synergies in the context of vertical and horizontal mergers, and probe into the

implications of financial synergies for optimal horizontal boundaries of firms.

Results of this thesis relate to at least three different literatures. First and foremost, they contribute to the literature on endogenous financial synergies that spans from Levy and Sarnat (1970) to Leland (2007) by showing that such synergies affect the real behavior of firms. Moreover, the normal distribution allows establishing new comparative statics of financial synergies, for example, the relation between the expected value of synergies and the average correlation of cash flows. Second, results contribute to the literature on the interaction between a firm's financial constitution and its product market behavior, for example Brander and Lewis (1986, 1988) and Povel and Raith (2004). Until now this literature has focused exclusively on single-product firms, and following chapters are a first step towards a proper multi-product analysis of links between real and financial spheres. Again the normal distribution allows for more advanced insights into comparative statics of firm behavior than previously available. Third and finally, results contribute to the literature on firm behavior under uncertainty, as sparked by Sandmo (1971) and Leland (1972). A paradigmatic result in this literature is that uncertainty has no impact on risk-neutral firms. This conclusion turns out to be not very robust to even slightly richer assumptions about the financial constitution of firms, and several results obtained with risk aversion and affinity can be shown to hold in the risk-neutral case as well.

Last but not least, the thesis contributes to the understanding of the recent global financial crisis. It is often argued that two root causes of this crisis were excessive lending by mortgage banks and excessive securitization of mortgage-related assets. The analysis in this thesis suggests these two causes can be interpreted in terms of real effects of a positive financial synergy. Banks had incentive to securitize mortgage-related assets because of a positive financial effect caused by the limited liability of special purpose entities used for securitization. This positive financial effect had a real impact on risk-taking behavior: securitization of assets induced firms to amplify the riskiness of assets, that is, to lend excessively to home owners with a relatively weak creditworthiness. Purely financial synergies resulted in excessive real risk-taking by banks and ultimately home owners.<sup>10</sup>

Some brief comments on how to read this thesis. The primer on synergies in the following chapter is relatively self-contained, and readers already familiar with the literature on operational and financial synergies may skip large parts. Combinations of chapter 3 (The Model) with either chapter 4 (Limited Liability), 5 (Distress Costs) or 6 (Asymmetric Corporate Taxation) can be read individually. Throughout the thesis, variables denoted by capital letters refer to expected values, while lowercase variables refer to ex post values (realizations of random variables), and starred variables refer to equilibrium or optimal values. Exceptions apply. There is no distinction between no-

<sup>10</sup>This argument is developed extensively in chapter 4.

tions of risk and uncertainty in the spirit of Knight (1971). Instead, risk and uncertainty always refer to the variability (as measured by the variance or standard deviation) of some random variable. Proofs of propositions can be found at the end of each chapter.

# Chapter 2

## A Primer on Synergies

*Synergy is the only word in our language that means behavior of whole systems unpredicted by the separately observed behaviors of any of the system's separate parts or any subassembly of the system's parts.*

— Buckminster Fuller in Operating Manual for Spaceship Earth

### 2.1 Introduction

Most people equate the notion of synergy with „the whole is greater than the sum of its parts“ or „ $2+2=5$ “. Actually, these are rather narrow and misleading definitions of a subtle and multi-faceted idea. Its historic origin is the Ancient Greek notion of *συνεργός* (*synergos*), which means „cooperative“ and „helpful in work“. <sup>1</sup> Today, the common understanding of „synergy“ is still very much entangled with these ancient roots (Corning, 1995). Broadly defined, synergies refer to the effects of interaction and cooperation — literally, the effects produced by things that „operate together“, for example, parts, elements or individuals (Corning, 2000). If a system achieves different things — more or less, for example — than a mere collection of the system's components, this is a positive or negative synergy, respectively. The decisive difference between a system and a mere collection of its components is interaction between components present in the system and absent in the collection, that is, synergies.

This primer is concerned with synergies in the realm of business, where they feature prominently in the context of mergers and acquisitions (M&A). Loosely speaking,

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<sup>1</sup>In Ancient Greek philosophy *συνεργόν* (*synergon*) is an item or idea that facilitates effects and events by making them „easier to occur“ (Hankison, 1999). In the Ancient Greek version of the New Testament *συνεργοί* (*synergoi*) is used to express that man is God's fellow coworker in the execution of the divine plan. For example, in the First Epistle to the Corinthians (3:8-9) Paulus writes „ὁ φυτεύων δὲ καὶ ὁ ποτίζων ἓν εἰσιν, ἕκαστος δὲ τὸν ἴδιον μισθὸν λήμψεται κατὰ τὸν ἴδιον κόπον, θεοῦ γὰρ ἔσμεν συνεργοί· θεοῦ γεώργιον, θεοῦ οἰκοδομή ἐστε“ (Westcott and Hort, 1885). In the World English Bible this translates to: „Now he who plants and he who waters are the same, but each will receive his own reward according to his own labor. For we are God's fellow workers (*συνεργοί*). You are God's farming, God's building.“



when firms merge and the „value“ of the merged entity is greater (lower) than the aggregate value of its constituent firms before the merger, this is a positive (negative) synergy.

Different stakeholders involved in an M&A undertaking worry about different aspects of synergies. For example, owners and managers of merging firms care most about the actual value of synergies, which they usually presume or hope to be positive. Consumers, competitors and competition authorities instead are more concerned with real effects of synergies, that is, with their impact on firms' operational and product market strategies, often called the merger's unilateral effects. For example, if a merger induces firms to charge higher (lower) prices, then consumers suffer (benefit) from the transaction.

In this primer theoretical causes and real effects of synergies are reviewed in the context of corporate diversification, that is, with reference to diversifying mergers of unrelated firms who are neither competitors nor in a supplier-customer relationship. The explicit focus on corporate diversification obviously excludes several important flavors of synergies.<sup>2</sup> For example, in the context of horizontal mergers of competitors synergies are often caused by the internalization of competitive externalities and scale economies. While such synergies are certainly important, they are well understood in theory and extensively documented in the literature. For the same reasons, synergies summoned by vertical mergers are neither considered. Instead, focusing on a simple example of a rational merger of two firms in unrelated industries, the primer focuses on synergies in the context of diversifying mergers. As will become more apparent in the following, it is therefore as well a primer on corporate diversification. Furthermore, concentration on a rational merger excludes several irrational merger motives, which have already been surveyed elsewhere.

Unsurprisingly, this is not the first survey on synergies and corporate diversification.<sup>3</sup> Its distinct novel contribution is the combined treatment of causes for and strategic effects of both operational and financial synergies. Operational synergies, which relate to the assets of firms, are usually examined in the industrial economics literature. Financial synergies in turn affect the liabilities of firms and are normally investigated in the corporate finance literature, with strong emphasis on causes for such synergies. A merger of these two separate literatures reveals that – even though real effects of operational synergies are well understood in theory – real effects of financial synergies are largely unknown and present a promising „white spot“ for future research.

<sup>2</sup>The interested reader may consult Whinston (2007) for a survey of the literature on horizontal mergers, Motta (2004) for a summary of theoretical research on vertical mergers, and Trautwein (1990) and Copeland et al. (2005) for a discussion on irrational merger motives. Pfähler and Bruder (2006a,b,c) focus on cost determinants of horizontal and vertical boundaries.

<sup>3</sup>For example, Montgomery (1994) and Briglauer (2000) survey the literature on corporate diversification, with strong emphasis on operational synergies. Bhide (1990) and Martin and Sayrak (2003) in turn both survey financial aspects of diversification but neglect operational aspects.

The primer proceeds as follows. The next section (2.2) introduces a simple example of a diversifying merger between two unrelated firms that allows to establish the basic economic logic of diversifying mergers and some working definitions that are used throughout the thesis. The next section (2.3) turns to specific causes for operational synergies, with emphasis on the example introduced in section (2.2). Section (2.4) covers specific causes for financial synergies. Section (2.5) discusses real effects associated with operational and financial synergies. Section (2.6) presents some stylized empirical facts about corporate diversification and synergies, and the final section (2.7) provides a short summary.

## 2.2 Basics of Diversifying Mergers

This section introduces a simple example of two unrelated firms who consider a diversifying merger, demonstrates why incentives to merge require synergies and explains two general causes for synergies in the context of diversification.

### 2.2.1 An Example

Consider two unrelated stand-alone single-product firms, denoted by  $A$  and  $B$ . Neither are firms competitors nor in a customer-supplier relationship, so there are no horizontal or vertical links between them. Each firm owns a single asset, a „factory” that represents a compound bundle of tangible and intangible productive resources that enable its owner to produce and sell a certain product. Let the factory of firm  $A$  be denoted by  $a$  and the factory of firm  $B$  be denoted by  $b$ . For the sake of concreteness, assume factory  $a$  produces sophisticated smart phones (think of iPhones or BlackBerries) and factory  $b$  state-of-the-art laptop computers (like MacBooks or ThinkPads). Let  $\Pi_a$  and  $\Pi_b$  denote expected net present values (NPVs) of factories.

Risk-neutral owners of firms  $A$  and  $B$  consider a diversifying merger that would create a single diversified two-product conglomerate denoted by  $M$ , where owners are those financial stakeholders of firms who „are in control”, so ownership is interpreted in terms of control rights in the following (Grossman and Hart, 1986; Hart and Moore, 1990). In case firms do not merge there is *corporate specialization*, with two completely specialized single-product firms, each owning a single factory. Alternatively, if firms merge, there is *corporate diversification*, since a single diversified multi-product firm owns and operates both factories.

Let  $Y_i$  be the expected *asset value* of firm  $i \in \{A, B, M\}$  and  $V_i$  the expected value of that firm to its owners, which is called the firm’s expected *market value*. The expected market value of a firm is usually not equivalent to the expected value of its assets, as several features of the nexus of contracts between the firm and its owners can drive a

*financial wedge* between  $Y_i$  and  $V_i$ . Examples of such features are limited liability, which implies that owners are shielded from the value of assets in some states of the world, or corporate taxation, which suggests owners have only access to the after-tax value of assets and not the pre-tax value  $Y_i$ . Let  $W_i$  be the expected value of this financial wedge, that is, the expected value of the difference between the asset and market value of firm  $i$ . Often  $W_i$  can be interpreted as the expected value of the firm to its (sometimes implicit) financial stakeholders who are not its owners and who have no control rights, for example, suppliers, tax authorities, employees and so forth.

Since the total value of assets is always conserved — this follows from the law of the preservation of value — it follows that the expected market value of firm  $i$  always satisfies

$$V_i \equiv Y_i - W_i. \quad (2.1)$$

The most important implication of this identity is that maximization of a firm's expected market value ( $V_i$ ) and maximization of the expected asset value ( $Y_i$ ) may be different objectives whenever the expected value of the financial wedge ( $W_i$ ) is different from zero. Depending on the sign of  $W_i$ , the market value of firm  $i$  may be both greater or smaller than the value of its assets. Now, under what conditions would two unrelated firms like  $A$  and  $B$  merge?

### 2.2.2 Incentives to Merge and Synergies

Firms  $A$  and  $B$  merge if their risk-neutral owners expect to be better off with a single diversified firm  $M$ , which is the case if the expected market value of a single diversified firm  $M$  exceeds the sum of expected market values of focused firms  $A$  and  $B$ , that is, in case

$$\Delta V = V_M - (V_A + V_B) > 0, \quad (2.2)$$

which means that owners have (*market value*) *incentives for corporate diversification* or *incentives to merge*. If the inequality is reversed the merger „harms“ owners, in which case they would have (*market value*) *incentives for corporate specialization* or *disincentives to merge*. Incentives or disincentives to merge require that firm owners collectively (and not necessarily individually) benefit or suffer from a merger. Condition (2.2) emphasizes that redistributive effects between different owners of a firm are usually not decisive for the merger decision. The total expected change in market values  $\Delta V$  determines whether owners will merge their firms or not (Scott, 1977).

For example, assume the only owners of firm  $i \in \{A, B, M\}$  are its shareholders and debtholders, where  $V_i^E$  and  $V_i^D$  are the expected values of equity and debt respectively, so that the expected market value is  $V_i = V_i^E + V_i^D$ . In reality, shareholders of firms  $A$  and  $B$  alone cannot enforce a merger, the firms' creditors will need to agree as well, as

debt contracts are usually equipped with covenants that constrain the ability of shareholders to pursue strategies that could imply losses for creditors. Since mergers are examples of such strategies, a merger can occur only if both shareholders and creditors agree. Application of condition (2.2) implies firms  $A$  and  $B$  will merge if

$$\Delta V = \Delta V^E + \Delta V^D > 0, \quad (2.3)$$

where  $\Delta V^j = V_M^j - (V_A^j + V_B^j)$  for  $j \in \{E, D\}$ . This condition includes cases where shareholders and creditors both expect to benefit individually from a merger (where  $\Delta V^E > 0$  and  $\Delta V^D > 0$ ) and cases where the gain of one class of owners exceeds the loss of the other (for example, where  $\Delta V > 0$  even though  $\Delta V^E < 0$  or  $\Delta V^D < 0$ ), meaning that the “winning” party can compensate the “loosing” party. In this case condition (2.3) is both necessary and sufficient for a (rational) merger.

To see this, consider either the market for corporate control, or a mix of side-payments and rational negotiation between shareholders and creditors. Consider the former argument first. If firm owners have collective incentives to merge but choose not to merge, then it is profitable for a corporate raider to gain control over focused firms by acquiring all outstanding equity and debt and then to merge firms. With a well-functioning market for corporate control, corporate specialization and incentives for corporate diversification are mutually exclusive in equilibrium (Manne, 1965). The other argument suggests that if one allows for side-payments and rational negotiation between shareholders and creditors, both will agree on a merger if and only if they have incentives to merge (Fama and Miller, 1972). Benefits to one party are not sufficient for a merger (for example, if  $\Delta V^E > 0$ ), since a party that expects to suffer from diversification ( $\Delta V^D < 0$ ) will then block the merger. Only if the losing party is compensated for its losses through side-payments from the winning party both will agree to the merger. The merger will therefore go through whenever both parties directly gain ( $\Delta V^E > 0$  and  $\Delta V^D > 0$ ) or if the gains of one party exceed the absolute value of the other party’s losses ( $\Delta V^E > 0$ ,  $\Delta V^D < 0$  and  $\Delta V > 0$ ), which is equivalent to incentives for diversification as defined in (2.2).

The expected total benefit or loss to owners triggered by the merger — the expected total change in market values as given by  $\Delta V$  — is equivalent to the expected value of synergies. To see this, realize that before and after a merger the total value of assets necessarily equals the total market value plus the total value of the financial wedge. So the total change in the value of assets  $\Delta Y = Y_M - (Y_A + Y_B)$  always equals the total expected change in market values  $\Delta V$  plus the total expected change in the value of financial wedges  $\Delta W = W_M - (W_A + W_B)$ . In other words, identity (2.1) holds as well „in differentials“. Overall, the impact of a merger on the total market value of firms

(incentives or disincentives to merge) is

$$\Delta V \equiv \Delta Y - \Delta W. \quad (2.4)$$

On the left hand side is the impact of a merger on expected market values. If this impact is positive there are incentives to merge since firm  $M$  is more valuable than firms  $A$  and  $B$  together, as in (2.2). If it is negative there are disincentives to merge, as two separate focused firms  $A$  and  $B$  are more valuable. The right hand side lists the possible origins of this change in the total expected market value of firms, namely the expected net value of *operational* and *financial synergies*.

The first term  $\Delta Y$  captures the expected value of *operational synergies*, that is, the total impact of the merger on the value of assets, in other words, its effect on the size of the “corporate pie” to be distributed between financial stakeholders of firms. If  $\Delta Y$  is positive (negative) there are positive (negative) operational synergies, and firm  $M$ ’s assets are more (less) valuable than the total assets of firms  $A$  and  $B$ , in expected terms. The expected value of *financial synergies* is summarized by  $\Delta W$ . If this differential is negative (positive) there are positive (negative) financial synergies, implying that after a merger firm owners expect to receive a relatively larger (smaller) share of assets than before the merger. Importantly, notice a non-zero financial wedge is a necessary condition for financial synergies: if the market value of a firm always equals the value of its assets there are no financial synergies.

In summary, the impact of a merger on market values can be split into separate effects of operational and financial synergies. Operational synergies relate to a firm’s assets and affect the amount of wealth to be distributed between all financial stakeholders, whereas financial synergies affect the distribution of wealth between owners and other financial stakeholders without control rights. Importantly, positive operational synergies and negative financial synergies are not mutually exclusive, so owners merge their firms only if they expect a positive net effect of synergies. The mere presence of either either positive operational or positive financial synergies is not sufficient to justify a merger. For example, only in the explicit absence of operational synergies ( $\Delta Y = 0$ ), the presence of positive financial synergies ( $\Delta W < 0$ ) is a sufficient condition for a merger. To determine the impact of a merger on market values of firms, both operational and financial synergies need to be considered. But why would a merger cause either operational or financial synergies in the first place?

### 2.2.3 General Causes of Synergies

In the introduction above, synergies were generally defined as effects of interaction and cooperation between components within a system. Consequently, a relatively higher or lower market value of firm  $M$  (the „system”) should be caused by some kind of interac-

tion or cooperation between factories  $a$  and  $b$  (the system's „components“) established if firms merge. Importantly, synergies should be caused by features of firm  $M$  that are neither easily replicated by focused firms nor easily avoided by the merged firm, that is, unique features of firm  $M$  (Teece, 1980). Otherwise firms  $A$  and  $B$  could reap the benefits of positive synergies without merging, and firm  $M$  could always avoid negative synergies simply by mimicking focused firms. What are these unique features?

The choice between corporate specialization and diversification boils down to a choice between different allocations of assets to horizontal boundaries of firms. As there are only two assets (the two factories) only two alternative allocations are possible.<sup>4</sup> Specialization suggests assets are decentralized, each is allocated to a single focused stand-alone firm with separate legal status. Instead, with diversification, assets are centralized within the boundaries of a single firm. From this angle there are two features unique to the merged firm. First, there is common instead of separate legal ownership of factories. Second, a merger allows for firm-based instead of market-based interaction between factories.

Consider firm-based interaction first. Clearly, specialization and diversification differ in the unique capabilities of the institutions that provide governance for interaction and coordination between assets (Williamson, 1975, 1985). With specialization interaction is necessarily constrained to arms-length market-based transactions and associated governance instruments. Diversification in turn involves hierarchical governance within the nexus of contracts that constitutes a diversified firm. These different institutional foundations cannot be avoided by firms, as the merged firm cannot perfectly replicate external markets inside its horizontal boundaries and focused firms cannot establish a hierarchical nexus of contracts between them (only a merger allows this).

The other unique feature unique of the merged firm is common instead of separate legal ownership of factories (Bhide, 1990). With diversification stakeholders like suppliers, employees, customers, competitors and tax authorities all interact with a single legal entity  $M$  whose economic condition depends on the aggregate fortune of both factories. This is different if firms choose not to merge, since stakeholders in that case interact with two separate legal entities  $A$  and  $B$ , and the fortune of each focused firm depends on a single factory only. Again, common legal ownership puts a constraint on the diversified firm that cannot be replicated by focused firms without merging.

Consequently, synergies (whether positive or negative) that arise in the context of

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<sup>4</sup>With more than two assets the number of possible allocations increases very quickly, at increasing rates. More precisely, given a set of  $n \in \mathbb{N}$  assets, the number of possible ways this set can be partitioned into nonempty subsets (that is, a number of  $m \leq n$  firms that collectively own all assets) is called the  $n$ th Bell number (for details, see Rota, 1964). Bell numbers can also be viewed as the number of distinct possible ways of putting  $n$  distinguishable balls (assets) into  $1 \leq m \leq n$  indistinguishable boxes (product portfolios, or horizontal boundaries of firms). The first few Bell numbers for  $n = 1, 2, 3, \dots$  are 1, 2, 5, 15, 52, 203, 877, 4140, 21147, 115975. With only a dozen assets there are already way more than a million possible mappings of assets to a dozen or less firms and their product portfolios.

diversifying mergers are ultimately caused by common instead of separate legal ownership of assets, and/or firm-based instead of market-based interaction between assets. Although these causes are very general, they establish an organizing framework for the examination of more specific causes. Such specific mechanisms through which firm-based interaction and common legal ownership cause operational and financial synergies are discussed in the following two sections. Firm-based interaction turns out to be most important for operational synergies, while common legal ownership is paramount for financial synergies.

## 2.3 Causes of Operational Synergies

This section reviews specific reasons why assets of firm  $M$  are more valuable than assets of firms  $A$  and  $B$  together ( $\Delta Y > 0$ ): excess capacity, internal (capital) markets, anti-competitive strategies and operational costs of risk. Causes are summarized in table (2.1). To focus on operational synergies, assume there are no financial synergies in this section ( $\Delta W = 0$ ).

### 2.3.1 Excess Capacity

Excess capacity is probably the most famous and least ambiguous cause of operational synergies. If there is excess capacity in a productive factor that is utilized by both factories  $a$  and  $b$ , and if market-based transfer of this excess capacity between focused firms is impossible or involves prohibitively high transaction costs, then there are positive operational synergies whenever the merged firm  $M$  is able to economize on this excess capacity.

Excess capacity results from a factor's incomplete congestion in the production process, which can occur if the factor is only available in imperfectly divisible quantities or exhibits some degree of non-rivalness, features encountered especially often in the context of knowledge intensive activities, like, for example, R&D and marketing. The most important consequence of economizing on such excess capacity is subadditivity of the cost function, most famously embodied in the concept of scope economies, which are said to exist if for all levels of output the costs of joint production after a merger is less than the total cost of producing each output separately before the merger (Panzar and Willig, 1981).<sup>5</sup> Economizing on excess capacity allows firm  $M$  to produce „cheaper“ than focused firms. For example, sophisticated mobile phones and laptops both require complex operating system software with largely identical components.

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<sup>5</sup>More precisely, if  $C(q_a, q_b)$  denotes cost of producing a quantity of  $q_a$  mobile phones and a quantity  $q_b$  of laptop computers, there are economies of scope for all output levels  $q_a \geq 0$  and  $q_b \geq 0$  if  $C(q_a, q_b) < C(q_a, 0) + C(0, q_b)$ , where cost of coordinated joint production within a single diversified firm are on the left hand side, and total cost of separate production of two focused firms on the right hand side.

<b>Causes of operational synergies</b>	
Excess capacity	If there is excess capacity in a productive factor that is utilized by several assets, and if market-based transfer of this excess capacity between focused firms is impossible or involves prohibitively high transaction costs, then there is a positive operational synergy whenever a diversified firm is able to economize on this excess capacity.
Internal markets	If a diversified firm establishes internal markets in which its business units compete for the firm's resources, then there is a positive (negative) operational synergy if such internal markets generate a more (less) efficient allocation of resources than reliance on respective external markets by comparable focused firms.
Anti-competitive strategies	If corporate diversification allows a diversified firm to pursue anti-competitive rent-seeking strategies (namely <i>cross-subsidization</i> , <i>collusion</i> and <i>product bundling</i> ) that are not available to focused firms, then there is a positive operational synergy.
Operational costs of risk	If the reduction in relative risk that is associated with diversification allows a diversified firm to economize on operational costs of risk, for example, costs of hedging, then there is a positive operational synergy.
<b>Causes of financial synergies</b>	
Limited liability	If limited liability allows firms to externalize negative asset values in some states of the world, then corporate diversification involves a negative financial synergy since the protection granted by limited liability against negative asset values is less complete with diversification.
Distress costs	If the reduction in relative risk that is associated with diversification allows a diversified firm to reduce its probability of distress, then there is a positive financial synergy if expected distress costs of a diversified firm are smaller than total expected distress costs of comparable focused firms.
Corporate taxation	If tax codes imply that diversified firms exhibit smaller expected payments to tax authorities than comparable focused firms, for example, because of asymmetric corporate taxation, then there is a positive financial synergy.

Table 2.1: Specific Causes of Operational and Financial Synergies



While firm *M* can develop a single operating system for both mobile phones and laptops, firms *A* and *B* need to develop redundant proprietary systems for their respective products. A diversifying merger then allows to economize on the excess capacity embodied in software development, making assets of firm *M* more valuable ( $\Delta Y > 0$ ).

Yet, the mere presence of excess capacity is generally not sufficient to summon incentives for corporate diversification (Teece, 1980, 1982). Transfer of such capacity is not only possible inside of a diversified firm's horizontal boundaries, in principal such capacity can be transferred across markets between focused firms as well. For example, if firm *B* has developed an operating system for its laptops that can be easily adapted to smart phones, there is no need for firm *B* to merge with firm *A* to economize on this excess capacity. Instead firm *B* can simply license the software to firm *A*. More generally, it is the facility with which excess capacity can be traded across markets that determines whether firms need to diversify to efficiently utilize it. Where market-based trading between separate firms is difficult and associated with high transaction cost, internal transfer exclusively feasible within a diversified firm often implies less frictions and more efficient governance, rendering diversification the superior alternative. This applies especially to information and highly specific assets (Teece, 1980). Market-based transfer of information is difficult because of the inherent conflict between convincing possible buyers of its value while simultaneously keeping the information sufficiently undisclosed until the buyer has paid for it. Similarly, in „thin“ markets for highly specific assets with very few suppliers and buyers, market-based transactions involve a struggle over the appropriation of quasi-rents.

Hence only the combination of excess capacity and market-imperfections that render capacity „unmarketable“ establishes incentives to merge because of a positive operational synergy ( $\Delta Y > 0$ ).<sup>6</sup> A brand is a prime example of such unmarketable excess capacity. For example, assume firm *B* has developed a well-established brand for mobile computing firm *A* has not yet successfully established. Such a brand clearly exhibits excess capacity that firm *A* could economize on. Yet, firm *B* will be reluctant to license its brand to firm *B*, since it has imperfect control over how the brand is (ab)used by firm *A*. Merging solves this problem.

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<sup>6</sup>The previous reasoning emphasizes cost effects of economizing on excess capacity. The resource-based theory of the firm, which envisions the firm as a set of resources that are the ultimate sources of profitability, argues that excess capacity has a much more general significance for profitability. A resource is anything that can be thought of as a relative strength or weakness of the firm relative to actual and potential competitors (Wernerfelt, 1984). From this angle, unmarketable excess capacity in a strong resource creates incentives for corporate diversification because of its overall effect on the competitiveness of firms. For example, assume firm *B* has excess capacity vis á vis firm *A* in the resource “ability to design, manufacture and sell stylish and easy to use mobile devices”. This resource is certainly hardly marketable, as it involves implicit knowledge, hard-wired managerial and technological skills, human capital and so forth. Therefore, only a merger of firms *A* and *B* allows to utilize this excess capacity in the mobile phone business, enabling it to draw on resources that are unavailable in an equilibrium with specialization, thereby raising its competitiveness, and, as a consequence,  $\Delta Y > 0$ .

Unmarketable excess capacity summons not only incentives for industrial, but as well for international diversification (Caves, 1971). Where market-based transfer of excess capacity from a domestic to a foreign market is impossible or very expensive — for example, because intellectual property cannot be protected — there is a genuine motive for foreign direct investment, that is, for internal firm-based transfer of excess capacity by means of „going abroad“ (international diversification).

### 2.3.2 Internal (Capital) Markets

If an internal capital market within firm  $M$  generates a more efficient allocation of resources than reliance on external capital markets, then assets of a diversified firm can be more valuable than assets of focused firms ( $\Delta Y > 0$ ). This specific cause of operational synergies is much more controversial than excess capacity, as internal capital markets can be shown to be less efficient than their external counterparts ( $\Delta Y < 0$ ).

The notion of an internal capital market usually refers to the additional administrative layer often found in diversified firms (Bhide, 1990). Whereas managers of stand-alone firms are directly answerable to external capital markets, managers of a diversified firm's business units often report to a corporate headquarter. Executives and their staffs in the corporate headquarter perform functions that would otherwise be performed by outsiders in external capital markets. Like investment analysts, they evaluate and monitor the performance of business units. Like external investors, they evaluate funding proposals and make resource allocation decisions. Like a bank, they offer cash management services and short-term financing. And, like the venture capitalists and private equity funds who sit on the boards of companies in which they have invested, they offer strategic advice. Such a corporate headquarter in effect constitutes an internal capital market (Williamson, 1975).

Internal and external capital markets represent different governance instruments. Reliance on external markets implies external (market-based) governance and control. Participants in external capital markets have only limited constitutional powers to conduct audits and limited access to the firm's incentive and resource allocation instruments (Williamson, 1975, 1985). Internal capital markets substitute certain aspects of external with internal (firm-based) governance. For example, executives in the general office are corporate insiders with superior access to information, and the hierarchical structure inside the firm also allows headquarters to act more effectively than outsiders on the information they possess. This suggests, for example, internal capital markets can better cope with opportunistic behavior of division managers, which would imply a positive operational synergy. On the other hand, internal capital markets could be outperformed by their external counterparts, given that internal markets might be comparatively slow, involve high fixed cost, are possibly biased toward re-

taining money in the firm, suffer from misaligned incentives and other deficiencies of hierarchical organizations, and generally lack the ever increasing sophistication of external markets (Bhide, 1990), which in turn suggests a negative operational synergy.<sup>7</sup> The relative (in)efficiency of internal capital markets is ultimately an empirical question.

Moreover, there is no reason why a focused firm should not be able to establish an internal capital market in the sense of an additional layer in the corporate hierarchy as well, it too could vertically integrate backwards into certain functions of external capital markets. Similarly, the merged firm  $M$  will implement an internal market only if it expects this to be profitable. Therefore, an internal capital market can only be considered a cause of operational synergies if it has unique advantages within a diversified firm. The most important advantage is *winner-picking*.<sup>8</sup>

Winner-picking refers to superior resource allocation abilities of internal capital markets within diversified firms. For example, assume factory  $a$  and  $b$  each require an equal amount of external finance, where the return on investment in factory  $a$  is higher than the return on investment in factory  $b$ . Without a merger, external capital markets allocate funds to each factory individually. After a merger this is no longer the case, since external markets can allocate funds only to a portfolio of factories (firm  $M$ ), which corporate headquarter in turn channels to factories. In a frictionless world both internal and external markets ensure both factories receive efficient funding. Yet, given some imperfection or frictions, internal markets could yield more efficient allocations than external markets. For example, assume there is both private information of division managers about true profitability of factories and credit rationing, so there is only enough external capital to finance either factory  $a$  or  $b$ . Efficiency requires factory  $a$  is financed (higher return). An internal capital market is more likely to yield this efficient allocation, since executives in the corporate headquarter of firm  $M$  are more likely to identify the profitable factory because of their superior access to information (Stein, 1997). The expected value of firm  $M$ 's assets is therefore going to be higher than the total expected value of assets of firms  $A$  and  $B$ . Such channeling of resources to their most profitable use is called winner-picking and usually cited as an advantage of

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<sup>7</sup>Especially in the presence of multi-layered principal-agent problems between owners, corporate managers and business unit managers, divisional rent-seeking may induce inefficient resource allocation, where weak divisions are subsidized by strong ones, thus creating divisional "socialism" (Scharfstein and Stein, 2000).

<sup>8</sup>Another advantage is internal financing. Given that factories  $a$  and  $b$  produce unrelated goods, it is quite likely that cash flows associated with factories are imperfectly correlated. This implies that excess funds generated by factory  $a$  can be used to finance a lack of funds encountered in factory  $b$ . With transaction costs in external capital markets, such internal finance will be less costly than funds raised in external markets. The firm avoids transaction cost associated with the sale of securities to the public, as well as costs of overcoming information asymmetry problems encountered when selling securities to outsiders (Martin and Sayrak, 2003). Such advantages of internal financing play important roles in portfolio concepts like the Boston Consulting Group's Growth-Share-Matrix, where "cash-cows" provide cheap finance for "rising stars".

internal capital markets within diversified firms.

More generally, any internal market within a diversified firm allows business units to compete for a conglomerate's resources, where resources include not just financial means, but as well human capital and other factors of production. Such internal competition is obviously not possible within focused firms. To the extent that internal markets are more competitive than external markets, such competition in internal markets may cause a positive operational synergy ( $\Delta Y > 0$ ).<sup>9</sup>

### 2.3.3 Anti-Competitive Strategies

If corporate diversification facilitates or enables certain anti-competitive rent-seeking strategies that are not available to focused firms (most importantly *cross-subsidization*, *collusion*, and *product bundling*), then there is a positive operational synergy ( $\Delta Y > 0$ ).<sup>10</sup>

The notion of cross-subsidization refers to the „dark side“ of internal capital markets and is the reverse of winner-picking. The idea is that resources are directed towards relatively unprofitable business units, instead of profitable ones, for pure rent-seeking motives. Such additional resources facilitate entry-deterrence strategies like limit-pricing (Cestone and Fumagalli, 2005; Faure-Grimaud and Inderst, 2005). If an incumbent business unit of firm  $M$  is threatened by a competitive entrant, corporate headquarter can either choose to channel resources away from this „attacked“ unit towards more profitable divisions (efficient winner-picking), or to support the threatened division by shifting resources away from other business units, for example, with the intention to deter entry by means of limit pricing or financial predation (inefficient cross-subsidization). The ability to quickly shift resources between divisions can be a competitive advantage for firm  $M$  relative to focused firms  $A$  and  $B$ , which need to acquire such resources externally. Hence it may cause a positive operational synergy ( $\Delta Y > 0$ ).

Furthermore, diversified firms may be able to sustain collusion in settings where cooperation of focused firms breaks down (Bernheim and Whinston, 1990; Spagnolo, 1999). To see this, assume there are two separate markets  $i \in \{1, 2\}$ , where firm  $A$

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<sup>9</sup>This idea applies especially in the context of international diversification that involves developing countries, where external markets and institutions work poorly (especially capital markets). For example, a multinational firm that operates a highly efficient internal labor market has an inherent advantage in developing countries, where focused firms are forced to rely on external markets only.

<sup>10</sup>There are several anti-competitive strategies available to diversified firms that are not discussed in this section. For example, diversified firms can benefit from reciprocal favors (Edwards, 1955; Moyer, 1970), meaning that several diversified firms engage in a reciprocal relationship, where firms share technologies, or buy and sell from each other. To the extent that such reciprocal behavior is motivated by rent-seeking and excludes other non-diversified firms, this can provide incentives for diversification. Furthermore, corporate diversification allows to internalize competitive externalities, making corporate diversification a rent-seeking strategy in itself. For example, if smartphones and laptops are to some extent substitutes (which is becomes increasingly reasonable) a merger between firms  $A$  and  $B$  will internalize such a competitive externality.

is in market 1 and firm  $B$  in market 2. In both markets firms  $A$  and  $B$  compete infinitely repeatedly in prices with focused competitors. As usual, collusion of firms within markets can be sustained by trigger strategies, where the rationale of each firm between deviation and continuation of collusion depends on expected NPVs of assets with collusion and deviation. Let  $\Pi_a^C$  be the expected NPV of factory  $a$  if firms in market 1 collude and  $\Pi_a^D$  the value in case of unilateral deviation by the owner of factory  $a$ , where the respective values for factory  $b$  in the other market are  $\Pi_b^C$  and  $\Pi_b^D$ . Now assume  $\Pi_a^C > \Pi_a^D$  and  $\Pi_b^C < \Pi_b^D$ , which means that without a merger collusion is sustainable in market 1 but unsustainable in market 2. Consider the impact of a diversifying merger, assuming firm  $M$  can either collude in both markets or deviate in both markets. Importantly, the choice between collusion and deviation now depends on aggregate and not individual expected NPVs of assets with collusion and continuation of deviation. More precisely, after a merger collusion is sustainable in both markets whenever

$$\Pi_a^C + \Pi_b^C > \Pi_a^D + \Pi_b^D, \quad (2.5)$$

that is, if the total expected NPV of factories with collusion is greater than the total expected NPV with deviation. This is possible if „slack“ cooperation enforcement capacity in market 1 ( $\Pi_a^C - \Pi_a^D > 0$ ) exceeds the lack of such capacity in the other market (the negative difference  $\Pi_b^C - \Pi_b^D < 0$ ), so that (2.5) is positive. In this case „pooling“ of incentive constraints makes complete collusion sustainable if firms merge, even though it is unsustainable without a merger.

Another well-known anti-competitive strategy exclusively available to diversified firms is product bundling, that is, firm  $M$  could choose to sell smart-phones and laptops only as bundles. This can have two advantages, the first being price-discrimination, since bundling allows a diversified firm to sort customers into groups with different reservation price characteristics, and this allows to extract consumer surplus (Adams and Yellen, 1976).<sup>11</sup> Another advantage is entry deterrence (Whinston, 1990; Nalebuff, 2004). If firm  $M$  has market power in both smart phones and laptop markets, it can make it harder for a single-product rival to enter the market. Bundling allows an incumbent to defend both products without having to price low in each. While it is still

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<sup>11</sup>For example, assume there are only two consumers, denoted by  $p$  and  $l$ , each one willing to buy both a single smart phone and a single laptop. Consumers differ in their willingness to pay: consumer  $p$  is willing to pay at most \$1000 for a fancy smartphone and \$800 for a laptop, while type  $l$  spends at most \$800 for a smartphone and \$1000 for a laptop. For simplicity, assume unit cost of production for smart phones and laptops are constant and roughly the same at \$500. Without a merger, firm  $A$  charges \$800 for its smartphones and firm  $B$  \$800 for its laptops, so each firm sells two products, and total profit of both firms amounts to \$1200. Firm  $M$  instead would choose to sell bundles of smartphones and laptops, at a price of \$1800, which yields a total profit of \$1600 that is higher than the profit of focused firms ( $\Delta Y > 0$ ). Notice that before the merger product prices are determined by the purchaser with the lowest willingness to pay, and the more diverse the valuations of consumers, the lower the price charged to sell a given number of products. Bundling in turn reduces the dispersion of the willingness to pay, allowing the diversified firm to charge a relatively higher price for the bundle.

possible to compete by offering a rival bundle, a monopolist can significantly lower the potential profits of a one-product entrant without having to engage in limit pricing prior to entry.

### 2.3.4 Operational Costs of Risk

The fourth and final specific cause of operational synergies are costs of risk that are associated with firms' operations. Relative to its size, firm  $M$  usually faces less of such costs than firms  $A$  and  $B$  together, which implies a positive operational synergy ( $\Delta Y > 0$ ). Corporate diversification usually involves a reduction of „relative risk“, where risk is relative to the size and scale of firms.

Formally, a firm's relative risk is measured by its coefficient of variation  $\xi = \sigma_i / Y_i$ , where  $\sigma_i$  is the standard deviation of assets and  $Y_i$  the expected asset value of firm  $i \in \{A, B, M\}$ . The coefficient of variation is a normalized and dimensionless measure of the riskiness of assets relative to their expected size and scale, in other words, the amount of risk per unit of expected asset value.<sup>12</sup>

Now let  $\Pi_a = \Pi_b = \Pi$  denote symmetric expected NPVs of factories and  $\sigma_a = \sigma_b = \sigma$  the symmetric standard deviation of NPVs. For each focused firm the coefficient of variation is then simply  $\xi = \sigma / \Pi$ . For the merged firm it is *total* risk of both factories ( $\sigma_M$ ) divided by the *total* expected NPV of factories ( $2\Pi$  if one assumes there are no other operational synergies), so firm  $M$ 's variation coefficient is  $\xi_M = \sigma_M / (2\Pi)$ . Total risk  $\sigma_M$  depends on the correlation coefficient of factories' NPVs.<sup>13</sup> If they are perfectly positively correlated the merged firm faces exactly twice as much total risk as each focused firm ( $\sigma_M = 2\sigma$ ), and with less than perfect positive correlation the merged firm faces less than twice the total risk ( $\sigma_M < 2\sigma$ ). Hence, while perfect positive correlation implies constant relative risk before and after the merger ( $\xi_M = \xi$ ), with less than perfect positive correlation the merged firm exhibits strictly less relative risk ( $\xi_M < \xi$ ). In other words, the diversified firm exhibits less risk per unit of expected NPV of assets. Notice operational synergies — for example, if the merged firm economizes on excess capacity — amplify the reduction of relative risk.

This purely stochastic risk-reduction or risk-smoothing effect is a well-known consequence of corporate diversification. Unfortunately, per se it is a rather poor motive for a merger and has received much criticism (Teece, 1980, 1982). Since expected asset values are the same with both specialization and diversification, risk-neutral firm owners do not care about more or less relative risk. But even if owners are risk-averse it is not obvious why firms should diversify. As owners can diversify their wealth portfolios themselves, there is no need to create a diversified firm  $M$  to reduce risk. More

<sup>12</sup>Alternatively, this coefficient can be interpreted as an inverse Sharpe ratio (Sharpe, 1994).

<sup>13</sup>Explicitly, if  $-1 \leq \rho \leq 1$  is the coefficient of correlation, the variance of the diversified firm's asset value is  $\sigma_M^2 = 2\sigma^2(1 + \rho)$ .

precisely, within the context of the capital asset pricing model (CAPM), a conglomerate merger will not reduce shareholder risk since all gains from this kind of portfolio diversification should have already been achieved by shareholders, since they are able to “diversify away” all unsystematic risk. The argument clearly applies only if the capital market is imperfect, so that shareholders cannot form a portfolio of firms  $A$  and  $B$ , or if shareholders not follow the CAPM (Levy and Sarnat, 1970).

The reduction of risk only causes a positive operational synergy if there are operational costs that are positively related to relative risk. Empirically, comprehensive risk management efforts and extensive hedging activities of firms against interest rate, exchange rate, commodity price and other kinds of risk indeed indicate that operational costs of risk are ubiquitous, as hedging can be a quite costly strategy (Stulz, 1984; Smith and Stulz, 1985). To see how diversification can reduce operational costs of risk, consider the following simple example. Assume factory  $a$  is based in Europe and sells its products predominantly to the US, which means that its costs are denominated in Euro while revenue accrues in US Dollars. Factory  $b$  is located in the US but sells its products mostly in Europe, so its costs are denominated in US Dollars while revenue accrues in Euros. Two focused firms  $A$  and  $B$  will most likely hedge against the associated currency risk. The merged firm  $M$  does not need such costly hedging, since both costs and revenues are perfectly diversified (a “natural hedge”). If the Euro appreciates, the profit of factory  $b$  increases (higher revenue) while profit of factory  $a$  decreases (lower revenue), and vice versa in case the Euro depreciates. Economizing on costs of hedging implies a positive operational synergy. Importantly, unlike other cause of operational synergies, risk-reduction requires no complex „post-merger integration”, it is a purely stochastic phenomenon. Notice there are certain techniques that allow focused firms  $A$  and  $B$  to reduce costs of risk without merging, using market-based contracts. For example, firms could engage in mutual lending, so that exchange rate changes have offsetting effects on mutual obligations (for details see Levi, 2005).

## 2.4 Causes of Financial Synergies

This section discusses specific causes for financial synergies: limited liability, distress costs and corporate taxation. To concentrate on financial synergies, assume there are no operational synergies in this section ( $\Delta Y = 0$ ). The example in table (2.2) is used for demonstration purposes, and causes are summarized in table (2.1) on page 24. Since remaining chapters of this thesis examine financial synergies in detail, the following exposition is rather casual and supposed to provide a broad survey.

	State 1	State 2	State 3
$\pi_a$	-\$120	-\$15	\$225
$\pi_b$	\$90	\$30	-\$30

Table 2.2: Ex post values of factories. All states of the world occur with equal probability. The expected value of each factory is  $\Pi_a = \Pi_b = \$30$ . The value of factory  $a$  is much more variable than firm  $b$ 's value, so factory  $a$  is „more risky“. Values are perfectly negatively correlated ( $\rho_{ab} = -1$ ).

### 2.4.1 Limited Liability

If limited liability (LL) of legal entities allows firm owners to externalize negative asset values in some states of the world, then a merger involves a negative financial synergy ( $\Delta W < 0$ ).

LL means that the liability of firm owners for their firm's obligations — for example, salaries claimed by employees, accounts payable to suppliers, warranty claims by customers — is legally limited to their initial investment in the firm. If the value of a firm's assets falls below zero, LL shields the private wealth of firm owners from the negative value of assets, that is, LL drives a financial wedge between (negative) asset and market values. Yet negative asset values do not simply vanish, they materialize into a loss for some stakeholders of the firm, for example, customers, suppliers, employees, the environment or society in general. LL may therefore be characterized as a legal institution that allows firm owners to externalize (a fraction of) negative asset values.

The early literature on financial synergies focused on the observation that LL of shareholders implies that debt of diversified firms is more valuable than debt of focused firms, since claims of creditors against a diversified firm are co-insured by several cash flow streams. This *coinsurance effect* was thought to mean that diversified firms can raise debt at lower interest rates (Levy and Sarnat, 1970; Lewellen, 1971). Yet, this was soon dismissed as a cause of financial synergies as defined in this primer, since the gain of creditors is neutralized by a matching loss of shareholders (Higgins and Schall, 1975; Galai and Masulis, 1976; Kim and McConnell, 1977). In other words, the coinsurance effect has no impact on the total market value of firms, it only affects how the value is distributed between firm owners.

After this brief period of confusion, the first robust result in the literature on financial synergies was that the collective protection of firm owners against negative asset values is more comprehensive with corporate specialization than with diversification, that is, specification allows firm owners to externalize a larger share of negative asset values than diversification (Sarig, 1985). More precisely, given LL of firm owners, corporate diversification offers only protection against a negative total value of assets,



	State 1	State 2	State 3
$v_A$	0	0	\$225
$v_B$	\$90	\$30	0
$v_M$	0	\$15	\$195
$\Delta v = v_M - \{v_A + v_B\}$	-\$90	-\$15	-\$20

Table 2.3: Market Values and Financial Synergies with Limited Liability

whereas specialization grants protection against any negative value of assets. Put differently, if owners of firms  $A$  and  $B$  merge, they relinquish dual ownership of two limited liability shelters for single ownership of a single limited liability, where the latter is less valuable than the former.

It is easy to demonstrate this effect in table (2.2). Assume that because of LL a firm's market value equals the value of its assets if that value is positive, whereas the market value is zero if the value of assets is negative. Ex post market values of firms  $A$ ,  $B$  and  $M$  with LL are summarized in table (2.3). Since the market value of firm  $M$  is smaller than the total market value of focused firms  $A$  and  $B$  in each state of the world, there are strictly negative financial synergies. In fact, a merger implies a 40% decline in the expected total market value of firms. Furthermore, notice firm  $A$  exhibits a higher expected market value than firm  $B$ , even though assets have exactly the same expected NPV, which suggests that limited liability creates a link between the volatility of a firm's assets and its market value.

Intuitively, the market value of a firm resembles a call option on the value of the firm's assets with a strike price equivalent to zero. With corporate specialization the total expected market value of firms  $A$  and  $B$  is equivalent to the expected value of a portfolio of call options on factories, and with diversification it resembles the expected value of a call option on a portfolio of factories. Rational option pricing suggests the latter is generally less valuable than the former (Merton, 1973).<sup>14</sup>

### 2.4.2 Distress Costs

If the reduction in relative risk that is associated with diversification allows a diversified firm to reduce its probability of distress, then there is a positive financial synergy if expected distress costs (DC) of a diversified firm are smaller than total expected distress costs of comparable focused firms ( $\Delta W < 0$ ).

DC arise because of frictions in the nexus of financial contracts between a firm, its owners and other stakeholders. Such frictions occur usually only if the value of a firm's assets falls below a critical threshold, as, for example, the nominal amount of

<sup>14</sup>A generalization of table (2.3) shows that the total market value of firms  $A$  and  $B$  first order stochastically dominates the market value of firm  $M$  (Kim and McConnell, 1977).

outstanding debt, or a publicly announced profit target. As long as the value of assets exceeds this critical threshold there are no frictions and therefore no DC.

Firm  $M$  often exhibits lower expected DC than firms  $A$  and  $B$  together. Intuitively, this is because diversified firms exhibit less relative risk than focused firms, as was already discussed above in section (2.3.4) on operational costs of risk. It follows that asset values which are „extreme“ relative to the expected value of assets occur with a relatively lower probability for diversified firms. Given that the threshold that triggers distress is usually proportional to the expected value of assets, diversified firms often exhibit lower expected DC than a comparable group of focused firms, a positive financial synergy. Casually speaking, because of diversification firm  $M$ 's business operations are “smoother” than operations of focused firms  $A$  and  $B$ . Again, the example in table (2.2) can be used to demonstrate this idea. Assume a firm's owners face costs of distress  $m\bar{D} > 0$  if the value of their firm's assets falls below zero, where  $m$  is the number of a firm's factories and thus a measure of its size, and  $\bar{D} = 3$  the amount of DC per factory. Notice how costs are strictly proportional to the expected asset value in this example. It is easy to check that a merger reduces total expected DC by more than 30%.

Theoretical evidence indicates DC can cause positive financial synergies (for example Higgins and Schall, 1975; Leland, 2007). Moreover, diversification not only reduces the expected value of DC, it reduces as well the variability of such costs (Yagil, 1989). Yet these results depend very much on the precise specification of DC, for example, whether they are predominantly bankruptcy costs or not, and whether they are fixed or proportional to asset values (Scott, 1977). Some specifications yield a negative financial synergy. Moreover, in the context of M&A, the sign of financial synergies caused by DC depends very much on how a transaction is financed. For example, if costs are predominantly bankruptcy costs that are triggered if a firm legally declares bankruptcy, then a heavily leveraged M&A undertaking can significantly increase the probability of distress and therefore the amount of expected costs of distress. DC are generally quite sensitive to a firm's financial constitution and capital structure. If this structure is deeply altered in the M&A process, as it is often the case, the change in the total expected value of DC can be ambiguous.

### 2.4.3 Corporate Taxation

A third and fairly uncontroversial cause of financial synergies is corporate taxation. The merged firm often faces a smaller expected payment to tax authorities than focused firms  $A$  and  $B$  together, in which case there is a positive financial synergy ( $\Delta W < 0$ ).

Various properties of tax tariffs cause financial synergies. An exposition of the technical details is beyond the scope of this primer, and the interested reader is referred to

a survey of Auerbach and Reishus (1988). Most famously, the consolidation of profits and losses that originate from different business units is often claimed to cause a positive financial synergy (Copeland et al., 2005). For example, assume firm  $M$  is allowed to deduct losses incurred by one factory from profits generated by the other factory for tax purposes, that is, assume the assessment or tax base of the merged firm is the aggregate or consolidated ex post value of both factories. Such consolidation of profits and losses is not a sufficient condition for a financial synergy. Consider the example in table (2.2), and assume a simple linear tax tariff  $t = \tau y$ , where  $0 < \tau < 1$  is the constant marginal tax rate and  $y$  the consolidated ex post value of a firm's factories. Clearly, there are no financial synergies, as the expected tax payment of the merged firm exactly equals expected taxes of focused firms.

Yet a sufficient condition for a financial synergy is that a tax tariff involves asymmetric treatment of profits and losses, that is, the government must be unwilling to participate equally in profits and losses of a firm (Heaton, 1987). For example, assume the marginal tax rate is 20%, and firms pay taxes only if the total value of their assets is positive, so that profits and losses are treated asymmetrically by tax authorities. Given pre-tax values of factories stated in table (2.2), the expected after-tax value of the merged firm is now 25% higher than the total expected after-tax value of focused firms before the merger, which is the result of a financial synergy. Such synergies arise in many settings with asymmetric tax codes, especially in the context of firm's with leveraged capital structures and tax deductible interest expenses (Scott, 1977; Leland, 2007).

## 2.5 Real Effects of Synergies

Having surveyed the causes for operational and financial synergies in previous sections, consider now real effects of synergies. The notion of real effects refers to a merger's impact on the product market behavior of merging firms. For example, assume the NPV of factory  $i \in \{a, b\}$  is

$$\Pi_i = \{p(q_i) - c_i\}q_i - F_i, \quad (2.6)$$

where  $q_i$  is output of factory  $i$ ,  $p(q_i)$  downward sloping inverse demand,  $c_i$  marginal and  $F_i$  fixed cost associated with factory  $i$ . In this case there is a real quantity effect in case equilibrium quantities before and after the merger do not equal.

Real effects determine how stakeholders like customers, competitors and suppliers are affected by a merger, and consequently they are paramount for the assessment of merger undertakings by competition authorities and for the overall significance of concentrations for an economy in general. From the perspective of a hypothetical com-

	Positive synergies ( $\Delta V > 0$ )	Negative synergies ( $\Delta V < 0$ )
Merger increases output	No conflict between firm owners and consumers: Firms merge and consumers benefit from the expansion of output, and the merger is approved by the CA.	Conflict between firm owners and consumers: Firms remain focused, although consumers would benefit from a merger. Should a merger be subsidized?
Merger decreases output	Conflict between firm owners and consumers: Firm owners would like to merge, but the CA intervenes and blocks the merger to protect consumers from a contraction of output.	No conflict between firm owners and consumers: Firms remain separate, so negative quantity effects do not arise, and intervention by a CA is not necessary.

Table 2.4: Combinations of Synergies and Quantity Effects

petition authority (CA) that claims to protect consumers (like the European merger authority) there are four scenarios that can emerge in the context of a merger of firms  $A$  and  $B$ , depicted in table (2.4). The combination of positive synergies and positive real quantity effects implies firm owners have incentives to merge, and consumers would benefit from such a merger. The mirror image of this scenario is the combination of negative synergies and negative quantity effects. Both constellations are unproblematic in the sense that there is no conflict of interest between firm owners and consumers, so intervention by a CA is not necessary. More complicated is the mix of positive synergies and negative quantity effects. Firm owners may have incentive to merge in settings where a merger reduces the surplus of consumers, which suggests the CA should intervene and block the merger. Alternatively, if a merger causes negative synergies but triggers an expansion of output, this could justify a subsidy, tax relief or other incentive for firms to merge. Overall, scenarios that involve a conflict between consumers and firm owners because of real effects represent a challenge for policy authorities.

Competition authorities concentrate on real effects of operational synergies when they assess proposed M&A undertakings, which are well understood in theory. Often such effects are formulated in terms of whether causes for operational synergies are predominantly *efficiency enhancing* or mainly *redistributional*. Positive operational synergies caused by excess capacity, internal capital markets and operational costs of risk belong to the efficiency enhancing category, as they improve the efficiency of production, organization, governance and so forth. In the context of a simple model of asset values like (2.6), efficiency enhancing synergies suggest that fixed and/or marginal cost of factories  $a$  and  $b$  are lower if firms merge. Real effects of a merger then depend on whether operational synergies affect fixed or marginal cost. Lower fixed costs usually have no implications for output of factories, but a significant decrease in marginal

cost has a positive impact on output, a real effect that benefits consumers. Overall, irrespective of whether higher efficiency manifests itself in lower fixed or marginal cost, real effects of efficiency enhancing synergies tend to have „non-negative“ consequences for welfare.

This is different with positive operational synergies caused by anti-competitive strategies, which have predominantly redistributive consequences: such synergies shift wealth from customers, competitors and other stakeholders to owners of merging firms. Real effects of such redistributive synergies tend to have negative implications for welfare and consumers. For example, if a merger increases the market power of firms or decreases the price-elasticity of demand, this allows firm *M* to reduce its equilibrium output and therefore to charge higher prices relative to stand-alone firms *A* and *B*. This real effect obviously harms consumers.

Generally, most merger undertakings involve a trade-off between efficiency enhancing and redistributive synergies. If efficiency enhancing aspects outweigh possible redistributive implications, a competition authority is supposed to approve an undertaking. In table (2.4), this is captured by the upper left cell. In the alternative case where redistributive aspects dominate a merger should be blocked, captured by the lower left cell in table (2.4). In the special case of diversifying mergers most competition authorities presume redistribution is unlikely, relative to horizontal and vertical mergers. In other words, real effects of operational synergies are not presumed to harm consumers, since efficiency enhancing aspects like economies of scope are presumed to dominate.

Very much unlike operational synergies, real effects of financial synergies have been completely neglected, both in the theoretical literature on financial synergies and in the realm of applied competition policy. The lack of interest by competition authorities is evident from the complete absence of references to financial aspects in the official US and European regulations on non-horizontal mergers and acquisitions (EU, 2007).<sup>15</sup> This neglect by practitioners follows naturally from a lack of theoretical foundations. In the canonical literature on financial synergies there are no real effects of financial synergies at all, as the real sphere of firms is an exogenous black-box.<sup>16</sup> The impact of financial synergies on firms' real behavior is therefore unknown. The general indifference with respect to a firm's real behavior in the (older) corporate finance literature is probably still motivated by the division of labor between industrial and financial economists, which dates back to the conjecture that a firm's real and financial decisions may be examined separately (Fisher, 1930; Modigliani and Miller, 1958, 1963). Yet, ever since Jensen and Meckling (1976) it has been very well known that a firm's financial

<sup>15</sup>There have been only very few cases where financial aspects indeed raised some concern, but in general financial aspects have been neglected.

<sup>16</sup>This includes all important contributions to the literature, that is, Levy and Sarnat (1970); Lewellen (1971); Higgins and Schall (1975); Scott (1977); Kim and McConnell (1977); Sarig (1985); Leland (2007).

constitution and the associated governance system have important implications for its operational strategy.

This interaction between financial and real decisions of firms has become one of the more promising avenues for research in industrial organization and corporate finance.<sup>17</sup> Yet there is no single established theory that connects a firm's real and financial spheres, but several contributions show how a firm's financial constitution is linked to its competitiveness and behavior in product markets.<sup>18</sup> Quite interestingly, this literature revolves around the same basic financial features of firms that cause financial synergies, namely limited liability, distress costs and asymmetric corporate taxation. For example, Brander and Lewis (1986, 1988) examine the impact of limited liability and distress costs on the product market behavior of firms. Whereas limited liability generally induces firms to pursue more risky product market strategies, distress costs lead to more prudent behavior. Similarly, Appelbaum and Katz (1987) examine the impact of asymmetric corporate taxation on production decisions of firms and identify (positive and negative) output distortions. The link between real and financial spheres examined in this literature suggests point to real effects of purely financial synergies. For example, if there is a negative relation between the probability of distress and firm output, then a purely financial synergy that reduces expected costs of distress could have a positive real quantity effect.

Real effects of financial synergies are therefore an interesting white spot for future work. To examine such real effects in theory, models that allow for both financial synergies and interaction between real and financial spheres are necessary. From a policy perspective, the central question to be examined in such a model is whether financial synergies are predominantly efficiency enhancing or redistributive.

## 2.6 Stylized Facts

A survey about synergies and associated real effects in the context of corporate diversification is not complete without a brief summary of stylized empirical facts and anecdotal evidence about the „average“ value of synergies and „mean“ direction of real effects. This section briefly presents some relevant pieces of stylized empirical and

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<sup>17</sup>Jean Tirole (2006) recently rated this research agenda as „under-explored but important“. Michael Riordan (2003) closed his keynote presentation — titled „How do capital markets influence product market competition“ — to the inaugural International Industrial Organization Conference finding that „the economics literature is poised for further theoretical and empirical advances on how capital markets influence product market competition“. Harris and Raviv (1991) find that „models which relate capital structure to products and inputs are the most promising“ areas for future research in the realm of corporate finance.

<sup>18</sup>The interested reader is referred to exhaustive literature surveys by Cestone (2000) and Franck and Huyghebaert (2004). The recent textbook on the theory of corporate finance by Tirole (2006) features an easy-to-read chapter on the issue.

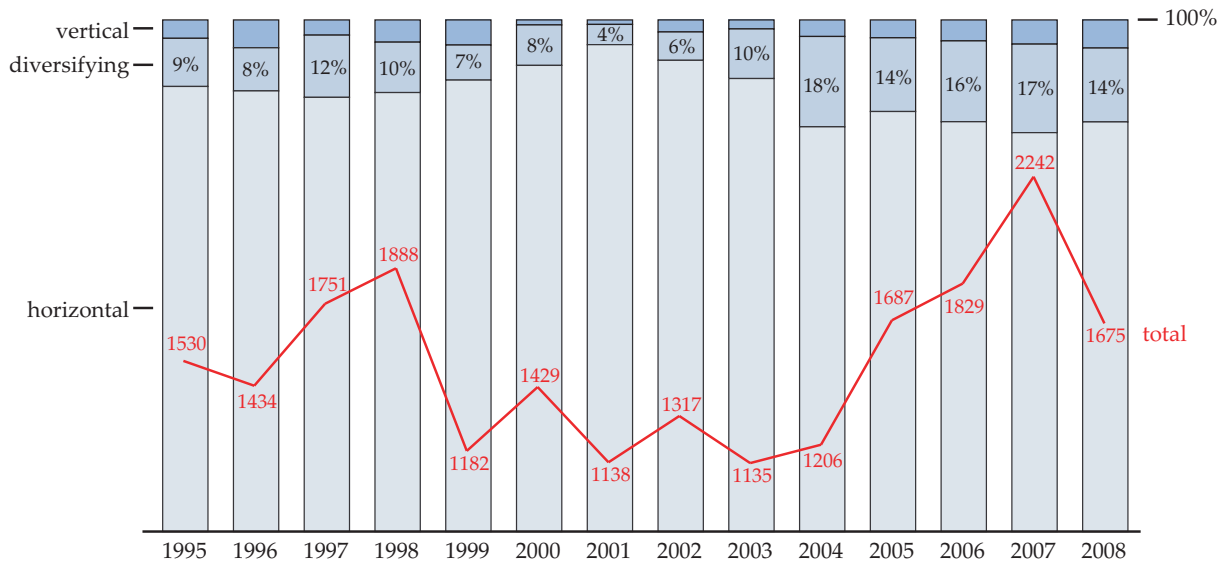


Figure 2.1: Mergers and acquisitions notified to the German Federal Cartel Office between 1995 and 2008, distribution by nature of transaction. Source: Annual reports.

anecdotal evidence.

First of all, diversification and synergies are en vogue. „The Return of the Multi-taskers (aka Conglomerates)” was the headline of a recent article in the New York Times, claiming „conglomerates are back, and back in a big way”.<sup>19</sup> A recent study by the Boston Consulting Group on „how the world’s top diversified companies produce superior shareholder returns” finds that many diversified companies „beat the average stock market, often by a significant margin, generating shareholder returns that are comparable to many of the top focused firms”.<sup>20</sup> Broadly diversified firms like Google, Nokia and Apple are prominent success stories of recent years. Reversing their dismissal in the 80ies of the last century, diversification and synergies are once again highly fashionable business topics.

Second, although even simple descriptive figures on the evolution and direction of diversification are surprisingly hard to provide, there is some evidence of recent increases in the extent of diversification. For example, Denis et al. (2002) report for a large sample of US firms that the fraction of globally diversified firms increased from 30% in 1984 to 45% in 1997, and that the average fraction of foreign sales of diversified firms has increased from 21% in 1984 to 30% in 1997. Similarly, figure (2.1) summarizes the structure of mergers and acquisitions notified to the German Federal Cartel Office and indicates that diversifying transactions become more frequent, indeed more frequent than vertical ones.

Third, there is no conclusive evidence on the average value of synergies. Practitioners and capital markets professionals often claim diversified firms trade at lower prices,

<sup>19</sup>„The Return of the Multi-Taskers (aka Conglomerates)”, *The New York Times*, August 5 2007.

<sup>20</sup>The study is available online at <http://www.bcg.com>.

notoriously known as the diversification or conglomerate discount. The existence of such a discount is still a hotly debated issue in the corporate finance literature. Martin and Sayrak (2003) survey the associated literature on the value of synergies, which basically compares the market values of diversified firms with the total market value of comparable sets of focused firms. They doubt the existence of a systematic impact of diversification on market values of firms, arguing that the „diversification discount is either not due to diversification at all, or may be a result of improper measurement techniques“. Generally, the average value of synergies is very difficult to measure, and there is no conclusive evidence that diversified firms are either substantially more or less valuable than comparable focused firms.

Fourth and finally, although empirical evidence on average real and behavioral effects of diversification is not available, there is some limited evidence that diversified firms behave differently in the product market. Diversified firms seem to achieve relatively smaller market shares (Mueller, 1985), appear to exhibit relatively higher leverage ratios (Ghosh and Jain, 2000), and to spend relatively less on R&D than focused firms (Denis et al., 2002). The fuzzy notion that diversified firms „do less“ is supported by Baumol (2002, p21), who argues that many revolutionary innovations were provided by independent specialized innovators and not by large diversified conglomerates. Overall, empirical research on the link between diversification status and product market behavior is absent.

Summing up, although research on the average value of synergies remains inconclusive, diversification and synergies are “hot” topics. The very limited evidence on real effects indicates that diversified firms “do less” rather than “more”.

## 2.7 Summary

This chapter surveyed causes and consequences of operational and financial synergies. Using an example of a diversifying merger of two firms in unrelated markets, it established definitions of operational and financial synergies, showed how such synergies establish incentives to merge, and discussed two general causes for synergies, namely the use of firm-based instead of market-based governance and centralized versus decentralized ownership of assets. Overall, causes for both operational and financial synergies are well understood in theory. Operational synergies arise because of excess capacity, internal capital markets, anti-competitive practices and risk-reduction, while the most important causes for financial synergies are limited liability, distress costs and corporate taxation.

The primer’s main finding is that research on real effects of synergies is heavily skewed towards operational synergies, while real effects of financial synergies present a “white spot” in the literature. Excess capacity, internal markets, and operational cost



of risk tend to cause efficiency enhancing synergies that have non-negative real effects for consumers, whereas anti-competitive practices cause redistributive synergies that tend to harm consumers and competitors. The nature of real effects caused by financial synergies is unknown. Consequently, the following chapter introduces a model for the analysis of such effects.

# Chapter 3

## The Model

*It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience.*

— Albert Einstein<sup>1</sup>

### 3.1 Introduction

This chapter introduces a simple merger model used to examine real effects of financial synergies in following chapters. Before the actual model is presented in the following section, consider first a brief introduction to the analysis in this thesis. The point of departure is a set of completely unrelated real assets, for example, several factories that each produces a different product. In the actual model assets are unrelated monopolies, but they could be any other real asset as well, R&D projects for example, so let's keep the idea of an asset fairly general for the purpose of this introduction. Furthermore, although the actual model is framed in terms of an arbitrary number, assume for a moment there are only two unrelated assets  $a$  and  $b$ , just like in the previous chapter. The analysis focuses on two simple questions:

1. Although the unrelatedness of assets implies there are no operational synergies, is there still a rationale for ownership of assets to be scattered across many specialized stand-alone firms, or is there a systematic centripetal force that draws assets into the horizontal boundaries of a single diversified firm? In other words, are there positive or negative financial synergies that establish incentives for either corporate specialization or diversification?
2. How are corporate strategies associated with assets — for example, quantities produced by factories or the amount of resources invested in R&D projects —

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<sup>1</sup>„On the Method of Theoretical Physics“, *Philosophy of Science*, Vol. 1, No. 2 (April 1934), pp. 163-169.

affected by corporate specialization and diversification? Put differently, are there real effects of purely financial synergies?

Just like in the previous chapter, the expected value of financial synergies in case of unrelated assets is defined as the difference between the expected market value of a single diversified firm  $M$  that owns and operates both assets  $a$  and  $b$  (corporate diversification) and the total expected market value of two stand-alone focused firms  $A$  and  $B$  that each own and operate only one asset (corporate specialization). Hence, to examine financial synergies, explicit assumptions about how the value of a firm's assets is translated to its market value are necessary. The translation or valuation mechanism depends on markets for corporate ownership and control, on the complex institutional and legal environments of firms, their governance systems and contractual foundations, in short, on the nexus of financial contracts that constitutes the *financial constitution* of firms. This constitution can be summarized by a *valuation function*  $v : \mathbb{R} \rightarrow \mathbb{R}$  that maps the value of a firm's assets  $y \in \mathbb{R}$  to its market value  $v \in \mathbb{R}$ . There are only very few a priori restrictions on this function. For example, if firms are required to pay a fixed lump-sum tax  $t > 0$  to tax authorities, then the valuation function is  $v = y - t$ . If the fee is set at \$300 and the asset value turns out to be \$1000, the market value of the firm is \$700. If the value of assets is only \$100, then the market value is indeed negative at minus \$200. Alternatively, if the value of assets is split between firm owners and tax authorities, according to a constant marginal tax rate  $\tau$ , then  $v = (1 - \tau)y$ . If the tax rate is 20%, an asset value of \$1000 translates to a market value of \$800, while an asset value of \$100 implies a market value of \$80.

Let  $\Pi_a$  and  $\Pi_b$  be random variables that capture the stochastic values of assets  $a$  and  $b$  (the notation is different than in the previous chapter, where  $\Pi_a$  and  $\Pi_b$  denoted expected values). The expected value of financial synergies — and therefore the answer to the first question — is then

$$\Delta V = E \left[ v(\Pi_a + \Pi_b) - \{v(\Pi_a) + v(\Pi_b)\} \right], \quad (3.1)$$

where the first term in the expected value on the right hand side summarizes the market value of a firm  $M$  that owns both assets  $a$  and  $b$ , and the second term the total market value of two focused stand-alone firms  $A$  and  $B$ . Quite obviously, the characteristics of the function  $v(\cdot)$  are decisive for the value of synergies. For example, Jensen's inequality suggests the expected value of synergies is weakly positive (weakly negative) if the valuation function is concave (convex). An important objective of the examination is therefore to spell out how certain characteristic features of a firm's financial constitution determine the nature of the valuation function  $v(\cdot)$  and therefore the expected value of financial synergies. Two axiomatic assumptions about  $v(\cdot)$  apply throughout the thesis. First, the market value is assumed to be non-decreasing in the

value of assets, and second, it is strictly linear in the ex post scale of firms. While the first restriction is just a matter of plain plausibility, as firms with more valuable assets should on average exhibit higher market values, the rationale for the second is more subtle. Technically, invariance to scale means that  $v(\alpha y) = \alpha v(y)$  for all  $\alpha \geq 0$  and  $y \in \mathbb{R}$ , so that if the asset value is scaled by a constant non-negative factor  $\alpha$ , the market value of the firm is scaled by the same factor. In other words, market values exhibit constant returns to scale in terms of ex post asset values. This assumption is essential for a non-trivial analysis of financial synergies. Otherwise there would be increasing or decreasing returns to scale in the market value of firms, which would constitute natural preferences for either „bigness” or „smallness” of firms, irrespective of corporate specialization or diversification.<sup>2</sup>

The second question probes into the real effects of financial synergies, which is the novel contribution of this thesis to the literature on financial synergies. In the previous chapter such real effects were defined as the impact of financial synergies on the product market or, more general, real (as opposed to financial) behavior of firms. To examine this notion formally, assume the random value of each asset depends on a control variable that is endogenously chosen by firms, that is,  $\Pi_a(x_a)$  and  $\Pi_b(x_b)$  are functions of control variables  $x_a$  and  $x_b$  that capture the real behavior or product market strategies of firms with respect to assets  $a$  and  $b$ , for example, quantities produced by factories or resources invested in R&D projects. Given the plausible assumption that risk-neutral firm owners choose controls that maximize expected market and not asset values, the second question can be phrased more technically as follows: does firm  $M$  choose different equilibrium values for its control variables than firms  $A$  and  $B$ , that is, are optimal choices of control variables contingent on corporate specialization and diversification of assets? To answer this question, detailed assumptions about the determination of asset values are necessary, indeed much more detailed than usual in the canonical literature on financial synergies, as exemplified by Lewellen (1971), Scott (1977) or Leland (2007). Most importantly, as these assumptions spell out how choices of control variables affect different stakeholders of firms (eg consumers and competitors), they allow assessing the distributional implications of financial synergies.

Thus answers to the two questions above require assumptions about how firm behavior determines the values of assets (the real sphere of firms), and about how the financial constitution translates the values of assets to the market values of firms (the financial sphere). The model introduced in this chapter focuses on the determination of asset values, while the relation between asset and market values is specified individually in following chapters. More precisely, each of the following three chapters focuses on a single characteristic feature of a firm’s financial constitution — namely limited

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<sup>2</sup>Specifically, increasing returns to scale would favor large diversified firms, while decreasing returns to scale would favor small specialized businesses.

liability, distress costs and corporate taxation — that causes financial synergies. That is, each chapter first introduces a specific form of the valuation function  $v(\cdot)$ , and then examines associated real effects of financial synergies in the context of the following asset model.

## 3.2 A Diversifying Merger

This section presents the workhorse merger model employed throughout the thesis. The model is remotely inspired by Brander and Lewis (1986, 1988) and Leland (2007), and revolves around a conglomerate merger of quantity-setting monopolists who operate in completely unrelated product markets and struggle with uncertain cash flows.

Consider a strictly risk-neutral one-period world where all agents exhibit zero time preference (no discounting whatsoever). There is a positive integer  $n \geq 2$  of unrelated product markets, indexed by  $i \in N = \{1, \dots, n\}$ . In each market  $i$  there is a single incumbent firm that produces a homogeneous market-specific quantity  $q_i$ . Markets are protected by barriers to entry, so there is neither actual nor potential competition.<sup>3</sup> Such a set of monopolistic product markets can be interpreted in terms of at least three different empirical settings. First, it relates to  $n$  markets for different goods. If cross-price elasticities between all markets are strictly zero, then products are neither complements nor substitutes, and markets are therefore said to be unrelated with respect to demand (for example, the markets for medical detection devices and the market for rail-cars are approximately unrelated). Second, each market may represent a different country or region. With high transportation costs, spatially separated markets are unrelated even if products are by their very nature complements or substitutes for consumers (for example, the provision of electricity in Germany and North America are largely unrelated activities). Finally, if third-degree price discrimination is feasible, markets might represent different horizontal market segments for a common good (for example, management consulting for blue chip industrial giants and small-to-medium enterprises).

Owners of the  $n$  firms can merge their businesses. If owners decide not to merge, there are  $n$  focused stand-alone single-product firms, each one a separate legal entity. This setting is called corporate specialization. Alternatively, if owners do choose to merge, there is a single legal entity  $M$  that is simultaneously engaged in all product markets, a setting called corporate diversification. The organizational and institutional details of the merger process are ignored. Given some exogenous valuation function  $v(\cdot)$ , owners merge their firms whenever they have incentives to merge because of positive financial synergies in the spirit of expression (3.1), that is, if the expected total

<sup>3</sup>The assumption of no competition is relaxed in later chapters.

market value of a single diversified firm  $M$  exceeds the total expected market value of  $n$  stand-alone firms. Alternatively, if separate firms are more valuable in expected terms, there is no merger. Notice that since firms are neither in a horizontal relationship as competitors in the same market nor in a vertical relationship as buyers and suppliers, this is clearly a diversifying (lateral or conglomerate) merger, and the emerging diversified firm resembles a conglomerate with  $n$  divisions or business units without separate legal status. Alternatively, in case each product market represents a different country/region, it is a cross-border or international merger, and the resulting diversified firm resembles a multinational corporation with affiliates and subsidiaries in  $n$  different regions/countries.

Cash flows associated with product markets are determined as follows. The cash flow associated with production and sales of output in market  $i$  is the difference between operating revenue and cost. Revenue in market  $i$  is characterized by price uncertainty. Let

$$\tilde{p}_i = p(q_i) + \epsilon_i^p \geq 0 \quad (3.2)$$

be the ex post price in market  $i$ . Inverse demand is stochastic in the sense that firms ex ante know only its expected value, its actual ex post realization is uncertain and contingent on a large number of independently but not necessarily identically distributed random shocks. Such shocks can arise from market-specific income fluctuations, or unexpected changes in preferences of consumers. Most generally, they simply capture the lack of complete information about demand. Let  $\epsilon_i^p$  in (3.2) be the sum of all such shocks to inverse demand in market  $i$ . Assuming that expectations of firms are rational (no systematic errors) it follows that the expected value of  $\epsilon_i^p$  is zero. Realizations of shocks are revealed to firms only ex post, after they have produced output. Hence there is price uncertainty ex ante but perfect information about prices ex post. As the expected value of shocks is zero, it follows that  $p(q_i)$  is expected inverse demand of consumers if the firm in market  $i$  produces a quantity  $q_i$ . Expected inverse demand is downward sloping in  $q_i$ , that is,  $(\partial p(q_i)/\partial q_i) < 0$  and concave in output, that is,  $(\partial^2 p(q_i)/\partial q_i^2) \leq 0$ .<sup>4</sup> Notice that with identical quantities  $q_i = q$  for all  $i \in N$  demand in markets is perfectly symmetric, at least in expected terms. Expected cross price elasticities between markets  $i$  and  $j$  are zero for all  $i, j \in N$  and  $i \neq j$ , so markets are completely unrelated with respect to demand, which means there is no demand-related merger motive, as, for example, bundling of related products.

Costs related to operations in market  $i$  are characterized by stochastic marginal cost and constant returns to scale and scope. Let

$$\tilde{c}_i = c + \epsilon_i^c > 0 \quad (3.3)$$

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<sup>4</sup>This assumption guarantees that expected cash flows are concave in output.

be the strictly positive value of marginal cost at the end of the period, there are no fixed cost. Similar to inverse demand, marginal costs are stochastic in the sense that firms *ex ante* only know their expected value. The actual *ex post* value depends on a large number of independently but not necessarily identically distributed random shocks that arise because of random fluctuations in input prices and stochastic properties of the production technology, for example, productivity shocks. The sum of shocks to marginal costs is  $\epsilon_i^c$  in (3.3). From the assumption of rational expectations follows that the expected value of  $\epsilon_i^c$  is zero. The actual value of marginal costs is not revealed until the end of the period, after firms have produced output. Hence there is cost uncertainty *ex ante* but perfect information about cost *ex post*, and  $c > 0$  is the expected value of marginal cost. Inputs to production are sourced on an upstream factor market. Importantly, firms pay for inputs only after they have produced and sold output.<sup>5</sup> Since delivery of and payment for inputs do not occur simultaneously, the implicit contract between downstream firms and upstream suppliers resembles trade credit financing, which is the empirically most widely used source of non-equity finance (Peterson and Rajan, 1997). As indicated by the empirical evidence on trade credit financing, assume expected prices for inputs are constant and independent of the product market behavior of downstream monopolists.<sup>6</sup> Notice there are no economies of scope, so markets are completely unrelated in terms of costs.

Overall, there are clearly no operational synergies in this setting. Given (3.2) and (3.3), *ex post* cash flow or operating profit — that is, the difference between operating revenue and cost — in market  $i$  is

$$\pi(q_i, z_i) = \{p(q_i) - c + z_i\}q_i, \quad (3.4)$$

where  $z_i = \epsilon_i^p - \epsilon_i^c$  is the realization of the market-specific random shock to the profit margin in market  $i$ . This shock is denoted by  $Z_i$  and captures the total effect of all uncertainty in market  $i$ . Since shocks to demand and cost are independently but not necessarily identically distributed, it follows from a central limit theorem that  $Z_i$  is normally distributed.<sup>7</sup> Since expectations of firms are rational, the expected value of

<sup>5</sup>This assumption is important for the analysis of limited liability in the following chapter.

<sup>6</sup>Terms of trade credit financing are empirically independent of borrowing firm's credit quality. For example, Peterson and Rajan (1997) and Ng et al. (1999) both provide empirical evidence that trade credit terms do not seem to vary significantly with borrowing quality, which is largely determined by the product market behavior of firms. One explanation for this observation is that trade credit allows for implicit price discrimination, since – given different borrowing qualities and constant trade credit terms – high quality customers in effect pay a higher price than low quality borrowers (Brennan et al., 1988). Alternative assumptions about credit terms are examined in chapter 4.

<sup>7</sup>Some remarks on the specification of uncertainty. Most results (but not all) derived in the following chapters do not hinge on specific assumptions about the distribution of uncertainty. For example, most results are qualitatively the same in case shocks are uniformly distributed. The normal distribution is mainly chosen for both its realism and analytical potential. Most importantly, as the normal distribution is replicative (contrary to the uniform distribution) some shortcuts are available that allow to signifi-

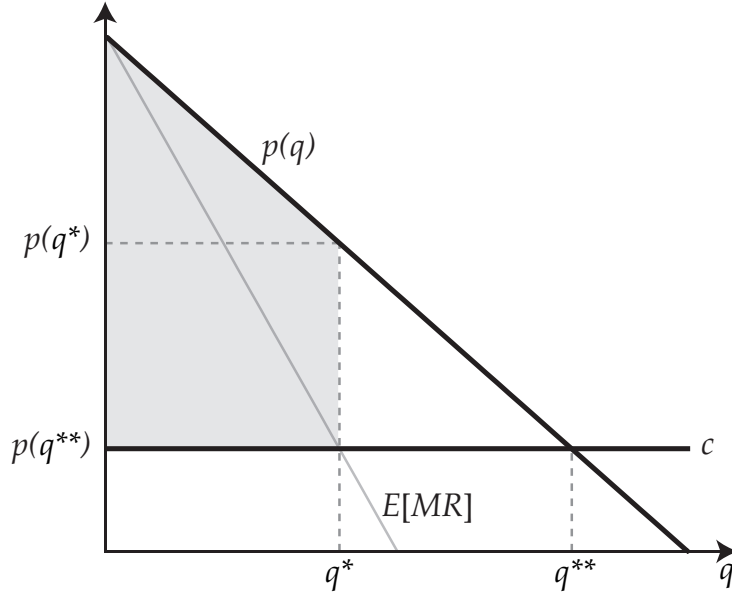


Figure 3.1: Optimal quantities  $q^*$  and  $q^{**}$  that maximize expected cash flow and welfare, respectively. Expected welfare in the representative market is given by the shaded area. The index  $i$  is suppressed.

$Z_i$  is zero ( $E[Z_i] = 0$ ). Let  $\sigma$  be the standard deviation and  $F(\cdot)$  the distribution function of  $Z_i$ . Once again, the specification of uncertainty implies realizations  $z_i$  are revealed by nature only ex post, after firms have irreversibly committed to a production quantity  $q_i$ . Ex ante there is thus both price and cost uncertainty, but ex post all uncertainty is resolved. There are thus  $n$  normally distributed market-specific shocks to cash flow, and the stochastic interaction of shocks  $Z_i$  and  $Z_j$  is summarized by the coefficient of correlation  $-1 \leq \rho_{ij} = \rho_{ji} \leq 1$ , where perfect positive correlation of shocks  $i$  and  $j$  implies by assumption that realizations of these shocks are always identical, that is, assume  $\rho_{ij} = 1$  implies  $z_i = z_j$ .<sup>8</sup> Notice each cash flow may be negative ex post.

It follows from (3.5) that cash flow  $\pi_i = \pi(q_i, z_i)$  associated with market  $i$  is the realization of a normally distributed random variable

$$\Pi_i = \{p(q_i) - c + Z_i\}q_i. \quad (3.5)$$

cantly simplify the analysis. The multiplicative impact of uncertainty on first-order conditions implied by (3.5) is necessary for real effects of financial synergies, see Brander and Lewis (1986) for a more detailed discussion of this issue. In case uncertainty affects cash flows only additively (and therefore does not enter first-order conditions) there are no real effects of financial synergies.

<sup>8</sup>Technically, perfect positive correlation of  $i$  and  $j$  is no sufficient condition for  $z_i = z_j$ , but for a deterministic linear relationship between shocks  $i$  and  $j$  in the form of  $z_i = \alpha_{ij} + \beta_{ij}z_j$ , with  $\alpha_{ij}$  and  $\beta_{ij}$  some constants. Assume in the following that  $\alpha_{ij} = 0$  and  $\beta_{ij} = 1$  for all  $i, j \in N$ . Furthermore, recall that the coefficient of correlation is symmetric since covariances are symmetric, that is,  $\rho_{ij} = \rho_{ji}$  because  $\text{Cov}(Z_i, Z_j) = \text{Cov}(Z_j, Z_i)$  for all  $i, j$ . Notice that for  $i = j$  it holds that  $\rho_{ii} = 1$  and  $\text{Cov}(Z_i, Z_i) = \text{Var}(Z_i)$ .



Thus cash flow in market  $i$  is distributed with moments

$$E[\Pi_i] = \{p(q_i) - c + E[Z_i]\}q_i, \quad (3.6)$$

$$\text{Var}[\Pi_i] = q_i^2 \sigma^2. \quad (3.7)$$

Output affects directly the expected value and variance of cash flow. More precisely, higher levels of output strictly increase the variance of cash flow, but may either decrease or increase expected cash flow. Expected cash flow  $E[\Pi_i]$  is maximized at the benchmark quantity  $q_i^*$  that solves first-order condition

$$\frac{\partial E[\Pi_i]}{\partial q_i} = \frac{\partial p(q_i)}{\partial q_i} q_i + p(q_i) - c + E[Z_i] = 0. \quad (3.8)$$

This quantity captures firm behavior in the absence of possible output distortions caused by a financial wedge between the value of assets and market values, and in subsequent chapters actual quantities chosen by firms are always compared against this benchmark quantity  $q^*$ , which is depicted in figure 3.1. Notice how uncertainty and a possible merger have no impact on the benchmark quantity, as it depends only on expected marginal revenue and expected marginal cost.

In later chapters, explicit numerical assumptions about moments of cash flows are required, that is, about (3.6) and (3.7). Besides specifications of expected demand  $p(q_i)$  and marginal cost  $c$ , this requires assumptions about the order of magnitude of the coefficient of variation of cash flows, which is determined by  $\sigma$ . Leland (2007) argues that — based on empirical estimates provided by Schaefer and Strebulaev (2004) and Leland (2004) — the standard deviation of cash flow should be calibrated to roughly 50% of its expected value, that is, in equilibrium

$$\frac{\sqrt{\text{Var}[\Pi_i]}}{E[\Pi_i]} \approx \frac{1}{2} \implies \sigma \approx \frac{p(q_i) - c}{2},$$

that is, the standard deviation should be about half the expected profit margin. For example, given linear expected demand  $p(q_i) = 10 - q_i$  and expected marginal cost  $c = 2$ , and assuming that firms produce the benchmark quantity  $q^* = 4$ , this suggests that  $2 \lesssim \sigma \lesssim 3$  is broadly in line with empirical estimates of cash flow volatilities.

The behavior of firms and the sequence of events are summarized as follows. Given some exogenous valuation function  $v(\cdot)$ , firm owners choose whether to merge their firms or not, based on the expected value of financial synergies. The random market values of a focused firm in market  $i$  and the diversified firm  $M$  are  $v(\Pi_i)$  and  $v(\sum \Pi_i)$  respectively, where random cash flow  $\Pi_i$  is given by (3.5). The definition of financial synergies in the case of two assets — see expression (3.1) above — suggests the

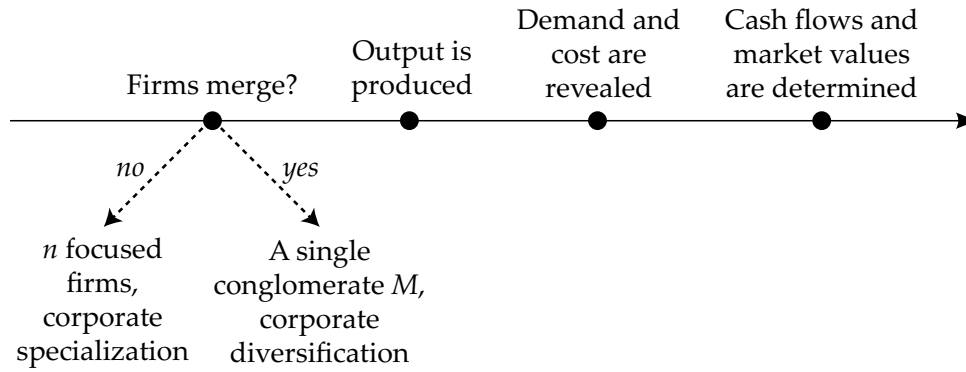


Figure 3.2: Sequence of Events in the Merger Model

expected value of synergies is

$$\Delta V = E \left[ v \left( \sum_{i=1}^n \Pi_i \right) \right] - E \left[ \sum_{i=1}^n v(\Pi_i) \right]. \quad (3.9)$$

If this expected value is positive owners go for corporate diversification and merge their firms, and if the value is negative or zero they stick with specialized stand-alone firms. Once horizontal boundaries have been determined, owners choose production quantities that maximize expected market values of their firms. Real effects are present if equilibrium quantities with specialization and diversification differ. After output has been produced, shocks to cash flows are revealed by nature, so that cash flows, market values and payoffs of other stakeholders are determined. Notice the overall simplicity of the setting: information is symmetric, cash flows are observable, and there is no agency problem. The model is summarized in figure 3.2.

Welfare depends crucially on output in this setting. Total expected welfare is given by total expected surplus of consumers and total expected cash flow in all  $n$  markets, where a firm's expected cash flow captures the firm's total value to its owners and other stakeholders („the corporate pie"). Formally, total expected welfare is

$$\sum_{i=1}^n \int_0^{q_i} \{p(t) - p(q_i)\} dt + \sum_{i=1}^n E[\Pi_i] = \sum_{i=1}^n \int_0^{q_i} \{p(t) - c\} dt, \quad (3.10)$$

where the first term on the left hand side is total consumer surplus and the second total cash flow. Welfare is maximized at the first-best quantity  $q^{**} > q^*$  that solves the implicit equation  $p(q^{**}) - c \equiv 0$ , that is, the quantity where expected price just equals expected marginal cost, depicted in figure 3.1. In later chapters this first-best quantity will serve as benchmark for firm behavior. Notice that both the expected surplus of consumers and overall welfare increase in quantities (as long as the expected equilibrium price is below the expected value of marginal cost).

From the perspective of a hypothetical competition authority (CA) that aims to pro-

tect consumers form harmful concentrations, four scenarios can emerge in this model, as was already mentioned in the previous chapter. The combination of positive financial synergies and positive real effects implies that firms have incentives to merge. Consumers benefit from such a merger. The mirror image is a mix of negative financial synergies and negative quantity effects, which suggests that firms choose not to merge, which is just fine with consumers. Both constellations are relatively unproblematic in the sense that there is no conflict of interest between firm owners and consumers, so intervention by a CA is not necessary. More complicated is the combination of positive financial synergies and negative quantity effects. Firms will engage in a merger that diminishes the expected surplus of consumers, so the CA will block the undertaking. Alternatively, if a merger causes negative financial synergies but triggers an expansion of output, this could justify a subsidy, tax relief or other incentive for firms. Overall, constellations that exhibit a conflict between consumers and firm owners are most interesting and challenging for policy authorities.

The examination of this merger model begins in the following chapter, where limited liability of firms determines a specific functional form of the valuation function. But consider first the alternative model in the following section.

### 3.3 An Alternative: Investment in R&D

The basic idea that purely financial synergies have significant real effects is quite general, and the specific nature of the associated story-telling device is not decisive. This section presents an alternative to the previously introduced merger model. This alternative model, which is inspired by Jensen and Showalter (2004), allows examining how incentives to invest in R&D depend on the legal organization of projects. All results derived in following chapters about the aforementioned merger model can be obtained in the context of the following alternative specification as well.

In a risk-neutral one-period world there is a portfolio of  $n \in \mathbb{N}^+$  unrelated R&D projects that search for discoveries with uncertain commercial values, indexed by  $i \in N = \{1, \dots, n\}$ .<sup>9</sup> Projects are either „securitized“ or „centralized“. Securitization of projects, which can be interpreted as corporate specialization, means there is an individual stand-alone firm for each project (a „special purpose entity“), so that there are  $n$  focused firms with separate legal status, each in charge of a single project only. Alternatively, with centralization all projects belong to the horizontal boundaries of a single common legal entity, so that there is only one firm that is engaged in all projects

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<sup>9</sup>Uncertainty is obviously a characteristic feature of investment in R&D. Some innovations exhibit surprising appeal to consumers (think of Google), while others fail for no apparent reason. For example, the technologically inferior Blu-Ray standard for high definition video discs recently prevailed over the competing allegedly superior HD standard. Technological pitfalls and the role of serendipity in the R&D process further amplify this uncertainty.

simultaneously, so centralization can be interpreted as corporate diversification. The owner of projects chooses the alternative that promises the highest total expected market value of projects.

Notice how these two different modes of organizing R&D relate naturally to different empirical patterns. The single large firm in case of centralization resembles a large and mature industrial conglomerate, as, for example, Pfizer, Apple, or Lockheed Martin. In the other case, where projects are securitized, the  $n$  stand-alone firms resemble small young start up firms that each focuses all its efforts on a single project. Since projects are completely unrelated and therefore exhibit no operational synergies, incentives to securitize projects require net negative financial synergies, in the sense that several securitized projects are more valuable than a single firm that owns and operates all projects.

Given an either centralized or securitized organization of R&D, the value of each project is determined as follows. If  $x_i > 0$  is the amount of resources invested into project  $i$  by its owner, the ex ante expected monetarized valuation attached to innovation  $i$  by consumers is  $\mu(x_i) > 0$ , that is, the project's strictly positive expected commercial value. The stochastic R&D technology  $\mu : \mathbb{R} \rightarrow \mathbb{R}$  that maps investment  $x_i$  to expected commercial values is characterized by Inada (1963) conditions

$$\mu(0) = 0, \quad \frac{\partial \mu(x_i)}{\partial x_i} > 0, \quad \frac{\partial^2 \mu(x_i)}{\partial (x_i)^2} < 0, \quad \lim_{x_i \rightarrow 0} \frac{\partial \mu(x_i)}{\partial x_i} = \infty, \quad \lim_{x_i \rightarrow \infty} \frac{\partial \mu(x_i)}{\partial x_i} = 0.$$

Without any investment a project exhibits zero expected commercial value, expected commercial values are twice differentiable and increase at decreasing rate in the level of investment, the expected marginal return to investment is very large for very low investment levels and nearly zero for very large levels of investment. Any investment  $x_i$  in project  $i$  is sunk and depreciates immediately, so  $x_i$  can be interpreted as an R&D expenditure. The actual ex post value of project  $i$  is  $\theta_i \mu(x_i)$ , where  $\theta_i$  is the sum of a large number of shocks that capture all uncertainty about the project. A central limit theorem suggests  $\theta_i$  is the realization of a normally distributed shock  $\Theta_i$  with support on the real line and unit mean (in line with rational expectations), standard deviation  $\sigma$  and distribution function  $F(\theta_i)$ . The stochastic interaction of shocks  $i$  and  $j$  with  $i, j \in N$  is again summarized by the coefficient of correlation  $-1 \leq \rho_{ij} = \rho_{ji} \leq 1$ . Realizations of shocks are revealed only after innovation and adoption have occurred, so output of projects has characteristics of experience goods, like, for example, drugs or complex defense systems.

Importantly, although expected commercial values of projects are by assumption strictly positive, the infinite support of shocks means each project may have a negative commercial value ex post. A project with a negative ex post value harms consumers, who consequently attach negative valuation to such projects. Plausibility of

this assumption is certainly corroborated by the „mixed“ track-record of modern industrial innovation, where seemingly harmless and valuable innovations have turned out very harmful. Examples include drugs with mutagenic side-effects like Thalidomide (known as Contergan in continental Europe), materials like Asbestos that are found to be carcinogenic, cars with hazardous design flaws, toys contaminated with lead, the sad story of the modern cigarette industry, and even certain instances of possibly large-scale experiments.<sup>10</sup> Therefore, if the commercial value of project  $i$  is positive (negative), then an innovation benefits (harms) consumers. In case of negative values consumers are legally entitled to compensation from the firm that owns project  $i$ , where the value of compensation demanded exactly equals the harm. Yet the appropriability of both positive and negative returns is imperfect. Explicitly, assume the firm appropriates only a fraction  $0 < \lambda < 1$  of a project's negative or positive commercial value at the end of the period. That is, it will only get some fraction  $\lambda$  of a valuable innovation, but is only forced to compensate consumers for a fraction  $\lambda$  of damages caused by an innovation.

Above assumptions imply the actual ex post net cash flow associated with project  $i$  (net of investment) is

$$\pi(x_i, \theta_i) = \lambda\theta_i\mu(x_i) - x_i, \quad (3.11)$$

which is the realization of a random variable

$$\Pi_i = \lambda\Theta_i\mu(x_i) - x_i \quad (3.12)$$

that is distributed with expected value and variance

$$E[\Pi_i] = \lambda E[\Theta_i]\mu(x_i) - x_i, \quad (3.13)$$

$$\text{Var}[\Pi_i] = \{\lambda\mu(x_i)\sigma\}^2. \quad (3.14)$$

Just like in the merger model, the amount of investment  $x_i$  directly affects both the project's expected cash flow and its variance, and more investment generates more variable results but not necessarily more expected cash flow. The benchmark amount of investment  $x_i^*$  that maximizes the expected cash flow (3.13) solves first-order condition

$$\frac{\partial E[\Pi_i]}{\partial x_i} = \lambda E[\Theta_i] \frac{\partial \mu(x_i)}{\partial x_i} - 1 = 0. \quad (3.15)$$

Clearly,  $x_i^*$  is governed by equality between expected appropriated marginal returns to investment and associated marginal cost, as depicted in figure 3.3. It is neither affected

<sup>10</sup>For example, the recently launched Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN) in Switzerland allegedly could lead to the creation of „micro black holes“ that are might be able to eventually destroy earth, at least in (some kind of more or less credible) theory (Posner, 2005).

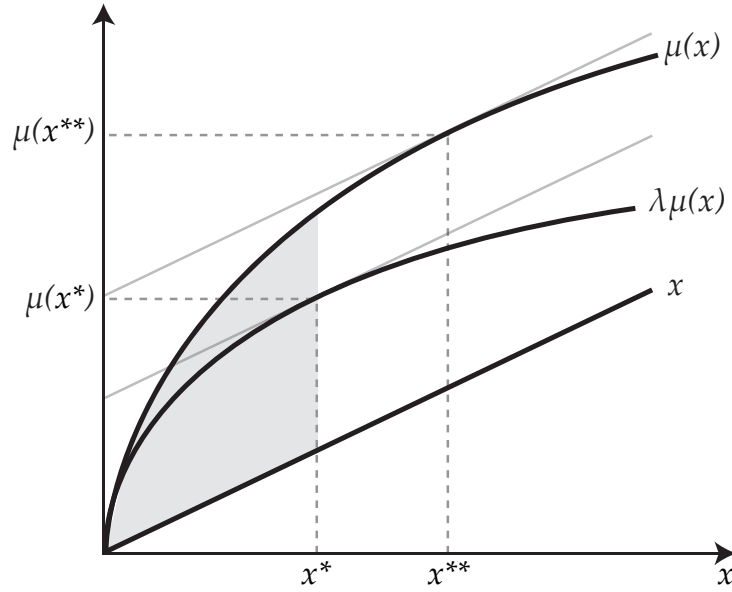


Figure 3.3: Optimal investment levels  $x^*$  and  $x^{**}$  that maximize expected cash flow and welfare in the alternative R&D model, where expected welfare is again given by the shaded area. The index  $i$  is suppressed.

by the extent of uncertainty nor by centralization or securitization of projects. Since only a fraction  $\lambda$  of a project's total commercial value is appropriated, the owner of projects has insufficient incentive to invest the socially optimal amount of resources into R&D. This socially efficient amount maximizes total expected welfare, which is given by the total expected surplus of consumers and total expected cash flow of all projects, that is, by

$$\sum_{i=1}^n (1 - \lambda)\mu(x_i) + \sum_{i=1}^n \{\lambda\mu(x_i) - x_i\} = \sum_{i=1}^n \{\mu(x_i) - x_i\}, \quad (3.16)$$

where the first term on the left hand side is surplus of consumers and the second total cash flow generated by projects. Clearly, only if firms are able to appropriate the complete value of a project ( $\lambda = 1$ ) they have first-best incentives to invest the efficient amount  $x_i^{**}$ , which is depicted in figure 3.3. Thus, with imperfect appropriability, equilibrium investment of firms is too low.

The sequence of events in the alternative model is summarized in figure 3.4. Depending on the expected value of financial synergies (see expression 3.9), the owners of projects decide whether to securitize or centralize projects and pick investment levels that maximize the total expected market value of projects. Finally, project values are revealed and payoffs determined.

Similar to the merger model, where firms produce not enough output because of their market power, the pivotal welfare issue in this alternative model is insufficient investment in R&D. The central question is therefore how centralization and securiti-

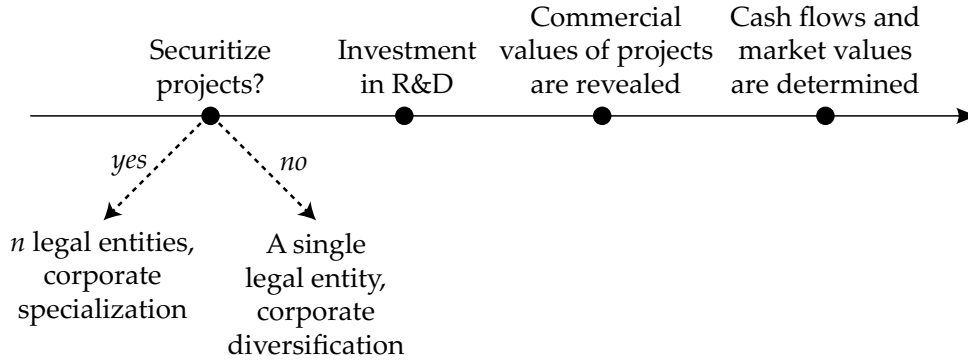


Figure 3.4: Sequence of Events in the Alternative R&amp;D Model

zation of projects motivated by positive or negative financial synergies affect incentives for the owner of projects to invest in R&D, that is, whether preferences of consumers and owners over different forms of the legal organization of R&D are aligned. Although the main part of the analysis focuses on the merger model in the previous section, selected references will be made in following chapters to this alternative specification.

### 3.4 Irrelevance

Generally, the value of financial synergies with  $n$  assets is a random variable defined as

$$\Delta v = v \left( \sum_{i=1}^n \Pi_i \right) - \sum_{i=1}^n v(\Pi_i), \quad (3.17)$$

where  $\Pi_i$  is equal to (3.6) in the merger model and given by (3.13) in the alternative R&D model. The first term on the right hand side is the random market value of a single legal entity  $M$  that owns all assets (corporate diversification), whereas the second term is the sum of random market values of focused legal entities that each own a single asset only (corporate specialization). As was already mentioned in the introduction to this chapter, characteristics of  $v(\cdot)$  are decisive for the value of synergies. For example, Jensen's inequality suggests synergies are weakly positive (weakly negative) if the valuation function is concave (convex). Much stronger statements about the value of synergies are derived in following chapters.

Two irrelevance results about corporate specialization and diversification are immediately available. First, if the ex post market value of firms strictly equals the value of assets, then the value of financial synergies is always zero, that is, a valuation function  $v(y) = y$  implies  $\Delta v = 0$ . In the merger model owners are indifferent towards the merger in this case, and given arbitrarily small transaction cost, they prefer not to merge and rather specialize. Similarly, in the R&D model owners of projects are in-

different between securitization and centralization of projects, and if centralization is slightly cheaper — which is plausible as it requires only a single legal entity — then projects are centralized. Second, identity between asset and market values implies specialization and diversification of assets have no real effects at all, as both specialized and diversified firms simply maximize the total expected value of cash flow (which is equal to the market value). In the merger model firms therefore always produce the benchmark quantity  $q_i^*$ , and in the alternative R&D model the benchmark amount  $x_i^*$  is invested into each project. These two irrelevance results summarize the conventional wisdom about unrelated corporate diversification: in the absence of operational synergies there is no incentive to merge, and a merger has no impact on the real behavior of firms.

### 3.5 Summary

This chapter introduced the simple merger model used to examine financial synergies and associated real effects in this thesis. The model allows examining endogenous corporate specialization and diversification with respect to an arbitrary number of real assets and a subsequent choice of operational strategies that determine the expected values and standard deviations of asset values. In the merger model assets are quantity-setting monopolies. After owners have chosen whether to merge their firms or not, firms produce output and cash flows are determined. In the alternative model assets are unrelated R&D projects, and the owner of projects first decides whether projects are centralized or securitized, and then how much to invest in each project. It was shown that identity between asset and market values is sufficient for the irrelevance of corporate specialization and diversification in both models.

Each of the following three chapters starts with a specific functional form of the valuation function that is characteristic for one of three essential characteristics of the financial constitution of firms that causes financial synergies — namely limited liability, distress costs and corporate taxation. The specific functional forms associated with these characteristics all share that at least in one state of the world  $v \neq y$ , so that specialization and diversification of firms is going to matter. Each chapter first examines the basic output distortion associated with this financial feature (independent of financial synergies and real effects), then checks whether it causes positive or negative financial synergies, and establishes whether synergies have a positive or negative real effect on quantities. Moreover, each chapter features applications and extensions of central results. Keep in mind that from a policy perspective, the central question is always whether incentives of firm owners and consumers are aligned, that is, whether financial synergies establish a rationale for some kind of regulation or intervention by competition authorities.



# Chapter 4

## Limited Liability

*Limitation is not a matter of justice. It is a rule of public policy which has its origin in history and its justification in convenience.*

— Lord Alfred Denning in *The Bramley Moore*<sup>1</sup>, commenting on the limitation of liability.

### 4.1 Introduction

Limited liability (LL) is a legal condition under which the involuntary financial loss of a firm's owners is limited to the amount of capital they have invested in their business. Relative to the alternative of unlimited liability (UL) — where the accountability of owners for their firm's actions and obligations is unlimited — LL is often said to facilitate the organization of economic activity inside of firms, most importantly, because it allows owners to externalize risk and losses associated with their business.<sup>2</sup> LL is a distinguishing characteristic of modern corporations, and in developed economies rather rule than exception. For example, according to the German Federal Statistical Office nearly 60% of firms in Germany enjoy LL.

This chapter examines implications of UL and LL for financial synergies and associated real effects in the merger model that was introduced in the previous chapter. The liability status of firms matters in this model because production is completely financed with trade credit, that is, firms pay for procured inputs only after products have been produced and sold. UL and LL have different implications for how trade credit claims of suppliers against a focused or diversified downstream firm are settled in states of the world where the downstream firm's total revenue falls short of its costs of production (a loss). Given that the nominal value of suppliers' claims equals the value of production cost (the account payable), UL means suppliers receive the full

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<sup>1</sup>Lloyd's Law Report No. 429 (1963), volume 2, p437.

<sup>2</sup>For a more general survey of the economics of limited liability, see Easterbrook and Fischel (1985).

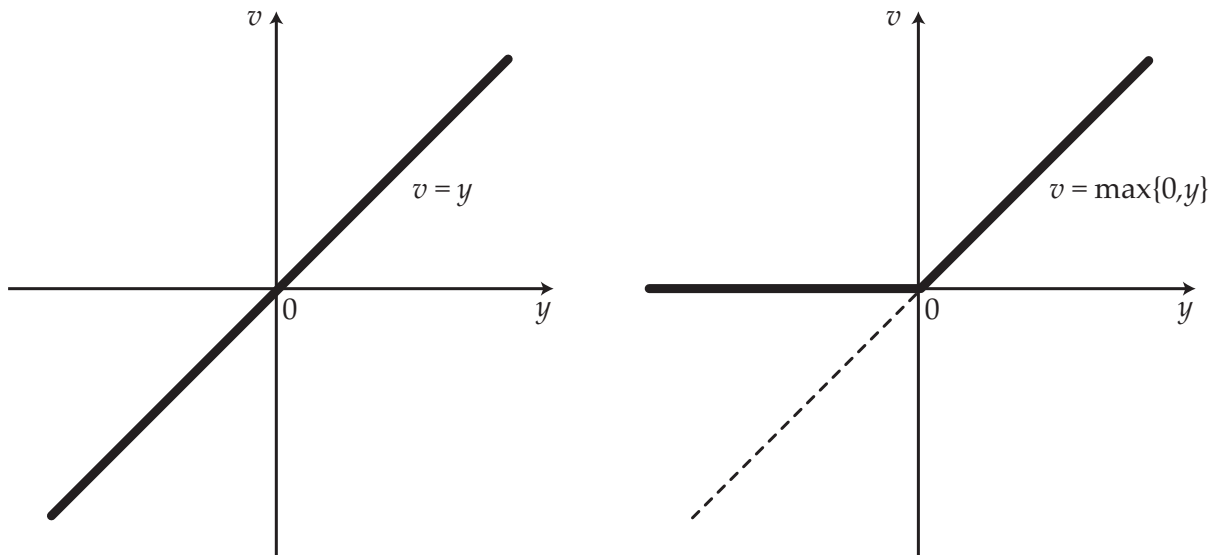


Figure 4.1: The function  $v(y)$  that translates the ex post value of a firm's assets  $y$  to its ex post market value  $v$  with UL (left) and LL (right). Along the dashed line  $v = y$ .

nominal value even from firms that have incurred a loss, as owners are accountable with their private wealth for losses of their firms. But with LL owners cannot be held accountable; they refuse to cover the negative difference between revenue and cost. Instead owners prefer to abandon their firm by filing for bankruptcy protection, for example, according to Chapter 7 (liquidation) in the US, so that suppliers become the firm's new residual owners. Thus with LL there is a financial wedge between the value of assets and the market values of firms.

More formally, UL and LL are easily captured by a valuation function  $v(\cdot)$  that relates the value of a firm's assets to its market value. Let  $y \in \mathbb{R}$  denote the ex post value of a firm's total cash flow, which is the only asset of firms in the merger model, as there is no initial capital contribution by owners. It follows from the above definition of LL that

$$v(y) = \max\{0, y\}, \quad (4.1)$$

whereas the alternative of UL implies  $v(y) = y$ . In all states of the world where cash flow is positive ( $y > 0$ ) there is no difference between UL and LL, since suppliers receive the nominal value of the account payable and the market value equals the value of assets ( $v = y$ ). But in states where cash flow is negative ( $y < 0$ ), the market value of the firm is zero with LL ( $v = 0$ ) and negative with UL ( $v < 0$ ). In other words, LL shields owners from negative cash flows, such cash flows are „externalized” or „socialized”, whereas UL implies „internalization” and „privatization”. Both specifications of  $v(y)$  are depicted in figure (4.1). Notice how both functions are non-decreasing in  $y$  and exhibit constant returns to scale, so the general requirements discussed in the previous chapter are satisfied. LL establishes a financial wedge that can cause financial synergies.

Using the above specifications of  $v(y)$  with UL and LL, financial synergies and real effects are examined in the following. As a preliminary exercise, section (4.2) commences with the basic output distortions associated with LL, as this greatly facilitates the central examination of synergies in section (4.3). Section (4.4) presents several applications and extensions of the analysis, and section (4.5) summarizes findings. Since a second aim of this chapter is to introduce the basic approach to the analysis in this thesis, the exposition and discussion is somewhat slower and more detailed relative to ensuing chapters.

## 4.2 Output Distortions

As LL essentially implies that owners can externalize losses, economic intuition suggests such a limitation should somehow bias firm behavior towards more risky projects and product market strategies. This section discusses such basic distortions and examines how a regime switch from UL to LL affects firm output and the comparative statics of market values and production quantities. Since the irrelevance result established in the previous chapter implies there are no output distortions associated with UL, the examination in this section focuses on LL.

In the merger model, consider a representative stand-alone firm  $S$  in some product market  $i \in N$  that maximizes its expected market value  $V_S$ , where the index  $i$  of variables is suppressed in the following to simplify the notation. As will become more apparent in the process, results about the behavior of this firm apply as well to the diversified firm  $M$  that emerges from a merger. Given the valuation mechanism specified in (4.1), the problem of firm  $S$  can be summarized as

$$\max_q V_S = \int_{-\infty}^{\infty} v(\pi(q, z)) dF(z). \quad (4.2)$$

Technically, because of the maximum function in the valuation function, (4.2) is the expected value of a truncated normally distributed random variable. The point of truncation is the critical realization  $\hat{z} \equiv c - p(q)$  of shock  $Z$  at which the representative firm's cash flow is exactly zero and the firm thus on the verge of bankruptcy.<sup>3</sup> For any given quantity  $q$  this critical realization splits the support of  $Z$  (the real line) into two distinct sections. For  $z > \hat{z}$  revenue exceeds cost: the firm's suppliers receive the full nominal value of the account payable, the firm exhibits positive cash flow and is solvent. For  $z < \hat{z}$  cash flow is negative because costs exceed revenue: owners file for bankruptcy and the firm's market value is zero, and not negative, because of LL. The probability of bankruptcy is  $F(\hat{z})$  and increases both in the level of output

<sup>3</sup>This mode of analysis was introduced by Brander and Lewis (1986).

( $\partial \hat{z} / \partial q > 0$ ) and in the expected value of marginal cost ( $\partial \hat{z} / \partial c > 0$ ). Intuitively, more output implies a higher probability of bankruptcy since a lower expected profit margin means that the firm becomes „more sensitive“ to negative shock values (recall that shocks affect the profit margin). Because of LL owners neglect all states  $z < \hat{z}$  of the world where cash flow is negative and instead focus on states  $z > \hat{z}$  with positive cash flow. In terms of the critical realization  $\hat{z}$ , the problem (4.2) of firm  $S$  can be expressed more conveniently as

$$\max_q V_S = \int_{\hat{z}}^{\infty} \pi(q, z) dF(z). \quad (4.3)$$

Generally, let  $V' \equiv (\partial V / \partial q)$  denote the first and  $V'' \equiv (\partial^2 V / \partial q^2)$  the second derivative of  $V$  with respect to  $q$ . The first-order condition of problem (4.3) is

$$V'_S = [1 - F(\hat{z})] \left\{ \frac{\partial p(q)}{\partial q} q + p(q) + E[Z|Z > \hat{z}] - c \right\} = 0, \quad (4.4)$$

and the second-order condition  $V''_S < 0$  is satisfied since  $V_S$  is by assumption globally concave in output.<sup>4</sup> The equilibrium quantity is independent of the firm's probability of bankruptcy and depends only on the sum in curly braces, which is expected marginal cash flow in states of the world where cash flow is positive. Firm owners therefore completely neglect implications of their quantity choice for states of the world where their firm ends up bankrupt, instead they focus only on states where the firm exhibits a positive cash flow. Let  $q_S^*$  be the unique equilibrium quantity that satisfies both first- and second-order conditions. As was already mentioned, it follows from the irrelevance result in the previous chapter that firms with UL produce  $q^*$ , the benchmark quantity that maximizes expected cash flow. The following proposition compares output of representative focused firms with UL and LL. Proofs of propositions can be found at the end of the chapter in section 4.6.

**Proposition 4.1.** *Equilibrium output of firm  $S$  with LL is strictly greater than the quantity that maximizes expected cash flow, that is,  $q_S^* > q^*$ .*

<sup>4</sup>A few remarks on first- and second-order conditions. Actually, because of Leibniz's rule there is a second term in (4.4). The complete expression is

$$V'_S = [1 - F(\hat{z})] \left\{ \frac{\partial p(q)}{\partial q} q + p(q) + E[Z|Z > \hat{z}] - c \right\} + \frac{\partial \hat{z}}{\partial q} \{p(q) - c + \hat{z}\} q f(\hat{z}) = 0.$$

Yet, from the definition of  $\hat{z}$  it follows that the second term is strictly zero. The second-order condition  $V''_S < 0$  is satisfied if  $V_S$  is globally concave in output. Let  $p'(q) \equiv (\partial p(q) / \partial q) < 0$  denote the first and  $p''(q) \equiv (\partial^2 p(q) / \partial q^2) < 0$  the second derivative of inverse demand. It follows that

$$V''_S = \int_{\hat{z}}^{\infty} \{p''(q)q + 2p'(q)\} dF(z) - \frac{\partial \hat{z}}{\partial q} \{p'(q)q + p(q) - c + \hat{z}\} q f(\hat{z}).$$

Since both terms are negative, the sign of the overall expression is indeterminate. Yet the second term is only of „second order“, which suggests that it is dominated by the first term, so  $V''_S < 0$ .

Firms produce strictly more output with LL than with UL, because LL shields owners from negative consequences of their output decision in bad states of the world, and the anticipation of this protection affects the ex ante output rationale. Maximizing the market value of their firm, owners focus only on states with relatively high demand and low cost, since these are states in which their firm is solvent (technically, the conditional expected value in (4.4) is strictly positive). The emphasis on high demand and low cost justifies higher output, relative to  $q^*$ . In other words, as LL allows owners to externalize losses in bad states, they can focus on good states and increase output relative to a setting with UL. Limited liability drives a wedge between expected marginal revenue and expected marginal cost in (4.4).

Recalling that the variance of cash flow in market  $i$  is  $\text{Var}(\Pi_i) = q_i^2 \sigma^2$ , proposition (4.1) suggests owners of firms with LL intentionally increase the variance of cash flow, relative to firms with UL. This effect is known as „risk shifting” and was first established by Jensen and Meckling (1976). The case of a soccer team that is behind two goals in a match with only a few minutes left to play helps to understand the intuition for this result. Explicitly, assume the score is 1:3, and the team has the choice between a low-risk and high-risk strategy. The low-risk strategy either improves the score to 2:3 or worsens it to 1:4 with equal probability in the remainder of the match, while the high-risk strategy either improves the score to 4:3 or worsens it to 1:6 with equal probability. The downside potential is basically the same with both strategies (defeat). Yet the high-risk strategy weakly dominates the low-risk strategy in the sense that it may win the game. The crucial point here is that the downside outcome for the team with both strategies is „limited from below” by the event of defeat, that is, the mere fact of defeat is pivotal, and not the „extent” of defeat. Just like LL, this limitation from below establishes incentives to pursue more risky strategies, in the case of soccer, for the benefit of the audience.

Consider now the comparative statics of firm behavior with LL. If firm  $S$  is subject to UL, its output and market value are independent of the amount of risk in its environment. This is different with LL, where an increase in  $\sigma$  has direct effects on a firm’s expected market value and indirect effects on its equilibrium output. Let  $V_S^* \equiv V_S(q_S^*)$  be the reduced form of  $V_S$ , the expected equilibrium market value of firm  $S$  at the optimal level of output  $q_S^*$ . The following proposition summarizes the effect of changes in  $\sigma$  on  $V_S^*$ .

**Proposition 4.2.** *The equilibrium expected market value of firm  $S$  is strictly increasing in the standard deviation of the cash flow shock, that is,  $(dV_S^* / d\sigma) > 0$ .*

With LL the firm resembles a call option on cash flow with a strike price of zero. It is a familiar property of call options that their value is increasing in the variability or riskiness of the underlying asset (Merton, 1973). As the variance of cash flow increases,

the firm's market value increases as well. Since expected cash flow is not affected by changes in the variance of shocks (holding output constant) it follows from the law of the preservation of value that the effective value of the account payable decreases as the extent of uncertainty about the product market environment increases. In other words, firm owners prefer more uncertainty to less, and vice versa for suppliers. Consumer surplus is not directly affected by changes in risk. Yet there is an indirect effect through the dependence equilibrium output of firms on the variance of cash flow shocks.

**Proposition 4.3.** *Equilibrium output of firm  $S$  strictly increases in the standard deviation of the cash flow shock, that is,  $dq_S^*/d\sigma > 0$ .*

Technically, output of firm  $S$  depends on the conditional expectation of the cash flow shock in states of the world where the firm is solvent, as is clearly visible in first-order condition (4.4). This conditional expectation increases in the riskiness of cash flow shocks (see Lemma 1 in section 4.7). In other words, as cash flow becomes more variable, expected marginal cash flow in those states of the world where the firm is solvent increases, and this justifies ever higher output. The increase in output triggered by a regime switch from UL to LL is therefore the stronger the more variable cash flows.

More intuitively, consider once more the example of the soccer team that is several goals behind. An increase in risk may be interpreted as a worsening of the score, for example, a change from 1:3 to 1:4. As the score worsens and time slips, ever riskier strategies are necessary to win the match, which in turn become ever more attractive to the team that is behind. High-risk strategies clearly resemble high quantity choices in the present model, since they promise high upside but limited downside potential. Again, like firm owners who focus on quantities appropriate for states of the world where their business is solvent, the soccer team focuses on strategies that yield victory.

A switch from a UL to a LL regime has straightforward welfare consequences. Consumers clearly prefer LL, since quantities are higher and expected prices consequently lower. Firm owners obviously like the limitation of liability as well, as it shields them from losses. Only suppliers prefer UL, as firm owners are always forced to pay the full nominal value of the account payable. Given the definition of welfare in the previous chapter, the total change in expected welfare triggered by a regime switch from UL to LL is

$$n \int_{q^*}^{q_S^*} \{p(t) - c\} dt > 0. \quad (4.5)$$

A sufficient condition for a positive welfare effect of LL is therefore that expected cash flow is non-negative in an equilibrium with LL, that is, the expected price must not fall below the expected value of marginal cost ( $p(q_S^*) \geq c$ ). Moreover, for every specific environment there exists a critical amount of risk at which expected price exactly equals expected marginal cost, that is, there is a  $\hat{\sigma}$  that solves the implicit equation

$p(q_S^*(\hat{\sigma})) = c$  and therefore maximizes expected welfare in settings where firms exhibit LL, this follows from proposition (4.3).

Overall, the liability regime has strong consequences for firm behavior and comparative statics. LL induces firms to produce more output and therefore alleviates the shortage that results from market power. Yet it may lead to „reckless“ behavior if firms choose output levels so high that the expected value of cash flow is actually negative. Although consumers always like the quantity effect of LL, the overall welfare impact can be negative if firms behave recklessly. Equilibrium market values and production quantities increase in the riskiness of the product market environment. The analysis of output distortions suggests that LL summons firm behavior that is observationally equivalent to risk-affinity: owners prefer more to less risk, and as risk increases owners choose ever riskier product market strategies.

### 4.3 Real Effects of Financial Synergies

Ever since Lewellen (1971) it has been known that LL causes negative financial synergies. Formally, if  $V_S^*$  is the equilibrium market value of the representative stand-alone firm  $S$  before a merger and  $V_M^*$  the respective market value of the merged firm  $M$  after the merger, and assuming there are no operational synergies, then the expected value of financial synergies given by

$$\Delta V \equiv V_M^* - nV_S^* \quad (4.6)$$

is known to be negative in settings where firms enjoy LL. To see why, consider the total ex post market values of firms before and after a merger. If firm owners choose not to merge (the case of corporate specialization) this total market value is

$$\sum_{i=1}^n \max\{0, \pi(q_i, z_i)\}, \quad (4.7)$$

and if they do choose to merge (corporate diversification) the market value of the single diversified firm  $M$  is

$$\max\left\{0, \sum_{i=1}^n \pi(q_i, z_i)\right\}. \quad (4.8)$$

The ex post value of financial synergies is simply the difference between (4.8) and (4.7). Since  $v(\cdot)$  is obviously convex, it follows immediately from Jensen's inequality that the total market value with corporate specialization is weakly greater than the market value with diversification. Corporate specialization features market-specific LL shelters, while a single diversified firm  $M$  enjoys only a single aggregate LL shelter. In

other words, owners of focused firms are shielded from any negative cash flow, but firm  $M$ 's owners are only protected from a negative total cash flow.<sup>5</sup> By merging firm owners relinquish a valuable market specific protection against losses against a less valuable aggregate protection (Sarig, 1985).

This section examines the nature of these financial synergies and their impact on equilibrium output of firms. As equilibrium quantities and market values with corporate specialization were already derived in the previous section, it remains to derive the equilibrium with diversification, where there is only one diversified multi-product firm  $M$  that is engaged in  $n$  unrelated product markets. Because of markets' perfect symmetry one may focus without loss of generality (importantly, only in the case of perfectly symmetric markets) on symmetric equilibrium quantities, so assume  $q_i = q$  for all  $i \in N$ .

The problem of owners is to choose a single symmetric quantity that maximizes the diversified firm's market value, that is, the expected value of (4.8). This problem, which arises again and again in different forms throughout the thesis, is significantly more complicated than the problem of each stand-alone firm, as it involves the expectation of a non-linear function of an arbitrary number of random variables. A convenient shortcut applied in this and following chapters is to express the problem of firm  $M$  in terms of an „average“ product market that is representative for the firm's overall portfolio of business units. To see that this is indeed possible, notice ex post total cash flow of all  $n$  business units can be stated in two equivalent ways, since

$$\sum_{i=1}^n \{p(q) - c + z_i\} q \equiv n \{p(q) - c + \bar{z}\} q, \quad (4.9)$$

where  $\bar{z} = \sum_{i=1}^n z_i n^{-1}$  is the mean of the  $n$  market specific shocks. On the left hand side of (4.9) is aggregate cash flow of all  $n$  product markets. On the right hand side, exactly the same aggregate cash flow is expressed in terms of a single representative product market that depends on the mean shock to operating profit. Hence firm  $M$ 's total ex post cash flow can be formulated as the outcome in an „imaginary“ representative product market times the number of business units.

Given this equivalence, firm  $M$ 's ex ante problem can be expressed in terms of a single new random variable, the mean cash flow shock  $\bar{Z} = \sum Z_i/n$  with realizations  $\bar{z}$ . Since the normal distribution is replicative, for any  $n$  the mean shock is normally distributed with probability function  $G(\bar{z})$ , expected value zero and standard deviation

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<sup>5</sup>For example, assume there are only two markets 1 and 2, and cash flow in market 1 is negative at -\$100 while cash flow in market 2 is positive at \$150, so that total cash flow is positive. According to (4.1), the total market value of two focused firms is \$150, since LL completely shields firm owners from the negative cash flow in market 1. A single merged firm would be worth only \$50, as LL applies to aggregate cash flow.



$\bar{\sigma}$ . Its standard deviation depends on the variance-covariance structure of the  $n$  shocks, which is conveniently summarized by a single parameter, the average coefficient of correlation

$$\bar{\rho} = \frac{\sum_{i=1}^n \sum_{j=1, j \neq i}^n \rho_{ij}}{n(n-1)}, \quad (4.10)$$

which is equal to the sum of all correlation coefficients of distinct variables divided by the total number of such coefficients. The standard deviation of the mean shock is therefore<sup>6</sup>

$$\bar{\sigma}(n, \bar{\rho}, \sigma) = \sqrt{\frac{\sigma^2}{n} + \frac{n-1}{n} \bar{\rho} \sigma^2}. \quad (4.11)$$

In the limiting case where all shocks are perfectly positively correlated ( $\bar{\rho} = 1$ ) the mean shock is exactly distributed as each single shock ( $\bar{\sigma} = \sigma$ ). If shocks are on average less than perfectly positively correlated ( $\bar{\rho} < 1$ ) then there is less risk in firm  $M$ 's representative market than in each individual market ( $\sigma > \bar{\sigma}$ ). In the special case of strictly uncorrelated shocks ( $\bar{\rho} = 0$ ) it follows that  $\bar{\sigma} = \sigma / \sqrt{n}$ , which implies that as the number of markets becomes extremely large the standard deviation of the mean shock becomes very small. In terms of the single representative product market, and given the valuation function specified by (4.1), the problem of firm  $M$  is

$$\max_q V_M = n \int_{-\infty}^{\infty} v(\pi(q, \bar{z})) dG(\bar{z}), \quad (4.12)$$

so the diversified firm actually focuses ex ante only on its representative market. Problem (4.12) is very similar to problem (4.3) of the stand-alone firm  $S$  examined in the previous section. Using a similar approach to this problem, let  $\hat{z} = c - p(q)$  be the critical realization of the mean shock at which firm  $M$  is just on the verge of bankruptcy. Whenever  $\bar{z} > \hat{z}$  the diversified firm's aggregate cash flow is positive, and in case  $\bar{z} < \hat{z}$  aggregate cash flow is negative and the firm bankrupt. Problem (4.12) is thus equivalent to

$$\max_q V_M = n \int_{\hat{z}}^{\infty} \pi(q, \bar{z}) dG(\bar{z}), \quad (4.13)$$

which is very similar to (4.3). The equilibrium quantity solves the first-order condition<sup>7</sup>

$$V'_M = n[1 - G(\hat{z})] \left\{ \frac{\partial p(q)}{\partial q} q + p(q) + E[\bar{Z} | \bar{Z} > \hat{z}] - c \right\} = 0 \quad (4.14)$$

<sup>6</sup>To see this, consider first the variance of  $\sum_{i=1}^n Z_i$ , that is, the variance of the sum of all random shocks  $Z_i$ , which is  $\sum_{i=1}^n \sum_{j=1}^n \text{Cov}(Z_i, Z_j)$ . This sum consists of  $n^2$  terms, of which  $n$  are variance terms (where  $\text{Cov}(Z_i, Z_i) = \sigma^2$  for each  $i$ ) while the remaining  $n^2 - n$  terms are covariance terms (where  $\text{Cov}(Z_i, Z_j) = \rho_{ij} \sigma^2$ ). The variance of  $\sum_{i=1}^n Z_i$ , may therefore be written as  $n\sigma^2 + \sum_{i=1}^n \sum_{j=1, j \neq i}^n \rho_{ij} \sigma^2$ . If  $\bar{\rho}$  is given by (4.10) the same variance may be written as  $n\sigma^2 + n(n-1)\bar{\rho}\sigma^2$ . Given that for any random variable  $X$  and a constant  $\alpha$  it holds that  $\text{Var}(\alpha X) = \alpha^2 \text{Var}(X)$ , it follows that (4.11).

<sup>7</sup>Similar to (4.4), there is actually a second term in (4.14) because of Leibniz's rule. Yet, this term is always zero and therefore omitted. See footnote (4) for details.

and second-order condition  $V_M'' < 0$ . Let  $q_M^*$  denote the equilibrium quantity in each market and  $V_M^* = V_M(q_M^*)$  the equilibrium market value of firm  $M$ . The diversified firm cares only about those states of the world where cash flow in the representative product market implies a positive total cash flow. Since this first-order condition is basically the same as the first-order condition of firm  $S$  in (4.4), it follows that all results derived in the previous section about the behavior of the representative focused firm  $S$  apply as well to the diversified firm  $M$ . It produces more output with LL than with UL, so  $q_M^* > q^*$ . Its expected equilibrium market value increases in the standard deviation of the mean shock  $\bar{\sigma}$ , while the expected total value of the account payable decreases. Firm  $M$ 's output increases in  $\bar{\sigma}$ , that is,  $(\partial q_M^* / \partial \bar{\sigma}) < 0$ . Since  $\bar{\sigma}$  depends on the number of markets  $n$ , the average correlation coefficient  $\bar{\rho}$  and each shock's standard deviation  $\sigma$ , the equilibrium quantity can be written as  $q_M^* \equiv q_M^*(\bar{\sigma}(n, \bar{\rho}, \sigma))$ . It is now straightforward to provide a strong statement about the expected value of financial synergies, that is, a strong sign of (4.6).

**Proposition 4.4.** *If shocks are perfectly positively correlated ( $\bar{\rho} = 1$ ) there are no financial synergies ( $\Delta V = 0$ ). Imperfectly correlated shocks ( $\bar{\rho} < 1$ ) imply strictly negative financial synergies ( $\Delta V < 0$ ). The expected value of financial synergies decreases as the average correlation coefficient decreases, that is,  $(\partial \Delta V / \partial \bar{\rho}) > 0$ .*

This confirms earlier results of Lewellen (1971): a conglomerate merger of firms with LL involves a negative financial synergy. The separate market-specific protection against negative operational cash flows offered by several stand-alone legal entities is more valuable to firm owners than protection against an aggregate loss (Sarig, 1985). Intuitively, the diversified firm experiences less risk in its average product market environment than each focused firm, a simple risk reduction effect of diversification. Since market values increase in the extent of uncertainty because of LL, a merger depresses total expected market values ( $\Delta V < 0$ ).

Again, this result can be interpreted in terms of call options: Merton (1973) showed how a call option on a portfolio of assets is always less valuable than a respective portfolio of call options on the very same assets. The diversified firm resembles such a call option on the  $n$  unrelated business units, while the case of corporate specialization can be interpreted as a portfolio of call options on each business unit. Only in the extreme case of perfect positive correlation, the cash flow in the diversified firm's representative market is indistinguishable from a focused firm's cash flow in a single market, and there are no financial synergies. Furthermore, the more negative cash flows are correlated on average, the lower the expected value of financial synergies. The left part of figure (4.2) graphs the expected value of the merged firm in percent of the total expected value of focused firms, depending on the correlation coefficient of cash flows, for a simple numerical example. Notice how the value of synergies decreases in the

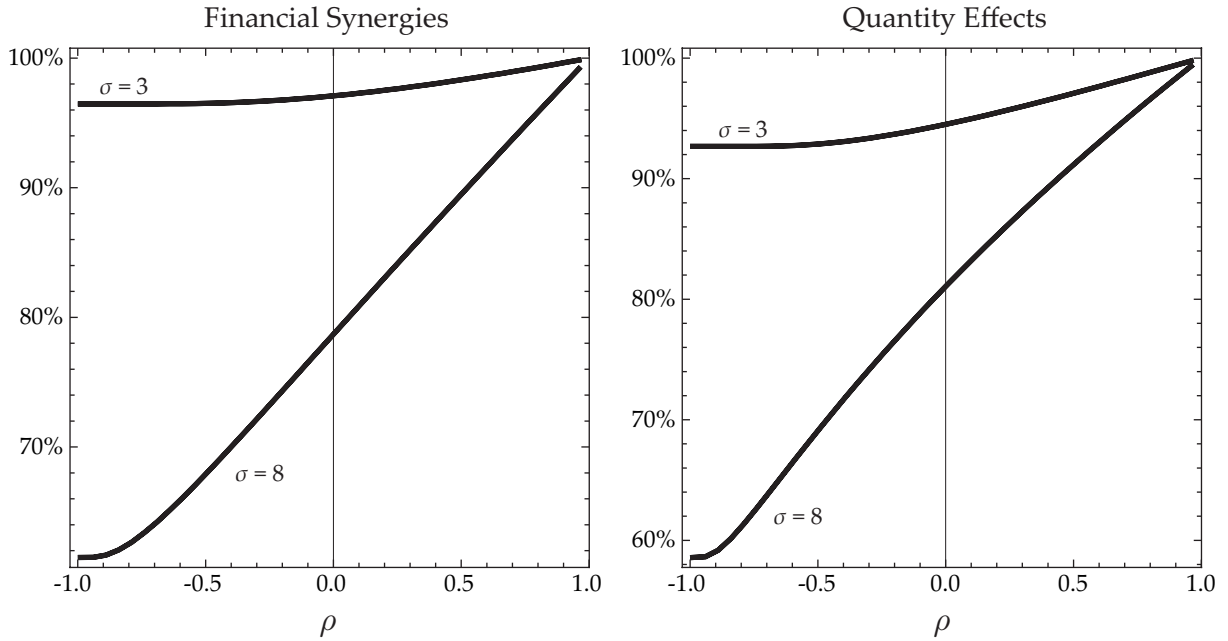


Figure 4.2: Numerical example with two markets ( $n = 2$ ), linear expected inverse demand  $p(q) = 10 - q$  and expected marginal cost  $c = 2$ . The left figure graphs  $V_M^*$  in percent of  $nV_S^*$ , and the right figure  $q_M^*$  in percent of  $q_S^*$ , both as a function of the average coefficient of correlation  $\rho$  for different degrees of risk.

riskiness of the product market environment.

Consumers are happy about the fact that firm owners have no incentive to merge, since they would suffer from the merger's real effects, as the following proposition summarizes.

**Proposition 4.5.** *If shocks are perfectly positively correlated there are no product market effects of a merger, and if shocks are imperfectly correlated output decreases if firms merge, that is*

$$\begin{aligned}\bar{\rho} = 1 &\implies q^* < q_M^* = q_S^*, \\ \bar{\rho} < 1 &\implies q^* < q_M^* < q_S^*.\end{aligned}$$

Output of firm  $M$  is generally increasing in the average correlation coefficient, that is,

$$\frac{\partial q_M^*}{\partial \bar{\rho}} > 0.$$

This is the first substantial result of this thesis. The purely financial synergy associated with LL has a real quantity effect. Equilibrium output is lower with diversification (firms merge) than with specialization (firms remain separate). Intuitively, a diversified firm expects less demand and higher cost in those states of the world where it is solvent, relative to a stand-alone firm, simply because the sheltering of LL against bad states of the world with low demand and high cost is less complete with diversification. The externalization of risk is less comprehensive with diversification. Real

quantity effects of a merger become stronger as the average correlation coefficient of shocks decreases. For example, in the special case with only two markets ( $n = 2$ ) and perfect negative correlation of shocks ( $\rho = -1$ ) the diversified firm produces the benchmark quantity  $q^*$  that maximizes expected cash flow, that is, the quantity that is optimal with UL, since a merger removes all quantity effects of LL. Examples of these results are depicted in the right part of figure (4.2), where  $q_M^*$  in percent of  $q_S^*$  is plotted as a function of the average correlation coefficient.

To summarize, in the presence of LL a merger involves a strictly negative financial synergy, and the more negative the average coefficient of correlation, the more negative the value of this synergy. An endogenous merger therefore requires an additional sufficiently large positive (operational or financial) synergy, otherwise the transaction is not profitable for firm owners. Furthermore, the purely financial synergy causes a negative real quantity effect that reduces the expected surplus of consumers. The overall impact of the merger on expected welfare is

$$-n \int_{q_M^*}^{q_S^*} \{p(t) - c\} dt < 0, \quad (4.15)$$

which is strictly negative for  $\bar{\rho} < 1$ , since then  $q_M^* < q_S^*$ . There is only one special case where a merger can increase expected welfare. If LL summons „reckless“ behavior of firms as discussed above, that is, if the output distortion associated with LL is so severe that with corporate specialization there is  $p(q_S^*) < c$ , then a merger that results in  $p(q_M^*) \geq c$  can actually improve expected welfare. But without reckless behavior there is no immediate rationale for policy intervention. Incentives of consumers and firm owners over the merger and therefore over corporate specialization and diversification are perfectly aligned, as both parties are worse off if firms merge. An endogenous merger that involves additional positive synergies that outweigh the negative LL synergy might still have a net positive real quantity effect. The fundamental insight is that the negative financial synergy caused by LL exerts a downward pressure on output.

## 4.4 Applications and Extensions

This section presents applications and extensions of the previous analysis. The common theme is the explanation of empirical observations and stylized facts by means of the above analysis. Topics covered include structured finance and the financial crisis, strategic costs of diversification in the context of Cournot competition and strategic debt, implications for the alternative model with investment in R&D and consequences of break-even trade credit terms.

#### 4.4.1 Structured Finance and the Financial Crisis

Structured finance concepts like „spinoffs“, „securitization“ and „project finance“ can be interpreted as the reverse of the merger examined above. In the merger, ownership of assets is centralized under the umbrella of a single legal entity, so that horizontal boundaries of firms become more diversified in the process. Many structured finance techniques aim at the exact opposite. For example, spinoffs and securitization mean that a firm sets up a separate legal entity with LL to which it transfers ownership of some of its assets. Similarly, project finance is a technique where new investment projects are organized as stand-alone entities with independent individual financing. These and other structured finance instruments imply specialization (and not diversification) of horizontal boundaries.

The above analysis suggests that corporate specialization by means of structured finance has a positive impact on total expected market values of firms, as more specialized horizontal boundaries allow for more comprehensive protection by LL and more comprehensive externalization of risk, this follows from proposition (4.4). Structured finance is therefore not just a job-creation scheme for investment bankers. Yet results of this chapter suggest as well that this positive financial effect of LL has behavioral consequences. Corporate specialization of horizontal boundaries was shown to yield comparatively risky real behavior of firms with respect to assets and projects, since the risk-shifting distortion caused by LL is more pronounced with specialization than with diversification, this is the mirror image of proposition (4.5). In the merger model, specialization implies lower expected and more variable cash flows than diversification. In a mean-variance framework asset values with diversification dominate asset values with specialization (notice this is a statement about values of assets, and not about market values of firms).

It is often argued that the surge in structured finance in recent years was one of the central causes of the global financial crisis that shattered the foundations of international capital markets in 2008. Banks loaded mortgage-related assets off their balance sheets into separate special purpose vehicles, and the highly specialized entities that emerged then issued the notorious „asset backed securities“. Banks issued too many and too risky mortgages, there was excessive lending, and the surge in securitization and structured finance was accompanied by ever riskier mortgage portfolios. This outcome can be explained in terms of the above discussed real effects of financial synergies. As securitization and more specialized horizontal boundaries allowed for more comprehensive LL protection, banks were more willing to lend to risky low-quality home owners. The result was (reckless) excessive lending. Like firms in the merger model, banks “produced” more mortgages with corporate specialization than with diversification, in fact too many (recall the discussion of reckless behavior caused

by LL). Securitized mortgage assets exhibited relatively low expected values and relatively high volatilities, just like in the merger model. In other words, the analysis of LL suggests excessive lending was a behavioral effect of a purely financial synergy.

#### 4.4.2 Strategic Costs of Diversification

Real effects of financial synergies can affect the competitiveness of firms in settings with strategic interaction. For example, there is empirical evidence that diversified firms achieve smaller market shares than comparable less diversified rivals (Mueller, 1985). Real effects of synergies caused by LL can explain this observation. As the analysis above was constrained to the monopoly case, consider now a variation of the merger model where a single conglomerate competes with several focused rivals in quantities, similar to Bernheim and Whinston (1990).

Assume there is a single conglomerate  $M$  that operates business units without separate legal status in each of the  $n$  product markets, so that the conglomerate owns a total of  $n$  business units (or divisions). In each market there is an independent focused stand-alone rival that competes with the conglomerate's business unit in quantities, that is, there are  $n$  duopolistic product markets. In each market, let  $q_S$  be the quantity offered by the focused firms and  $q_M$  the quantity offered by the conglomerate's business unit. The diversified firm and its focused rivals exhibit identical expected marginal cost.

Once again, the analysis can be greatly simplified by directly framing decision problems in terms of representative markets. Let  $\pi(q_j, q_{-j}, z_i) = \{p(Q) - c + z_i\}q_j$  be the cash flow of firm  $j$  in market  $i$ , given that quantities of firm  $j$  and its competitor  $-j$  are captured by  $q_j$  and  $q_{-j}$  respectively. Total output in each market is  $Q = q_j + q_{-j}$ . It follows from (4.3) that the expected market value of a representative focused firm  $S$  is

$$V^S = \int_{\hat{z}}^{\infty} \pi(q_S, q_M, z) dF(z), \quad (4.16)$$

where  $\hat{z} = c - p(Q)$  is the critical realization of the stand-alone firm's cash flow shock. Shock  $Z$  is distributed with cumulative density  $F(\cdot)$ , zero mean and standard deviation  $\sigma$ . Expression (4.13) in turn implies the market value of the conglomerate with its  $n$  subsidiaries is

$$V^M = n \int_{\hat{\bar{z}}}^{\infty} \pi(q_M, q_S, \bar{z}) dG(\bar{z}) \quad (4.17)$$

where  $\hat{\bar{z}} = c - p(Q)$  is the critical realization of the conglomerate's mean shock. The mean shock  $\bar{Z}$  in the imaginary representative market is distributed with cumulative density  $G(\cdot)$ , zero mean and standard deviation  $\bar{\sigma}$ .

Assuming firms engage in one-shot Cournot competition, the Nash equilibrium is determined by optimal quantities  $(q_S^*, q_M^*)$  that solve the system of first-order condi-

tions ( $V_S^S = 0, V_M^M = 0$ ). The following proposition characterizes this equilibrium.

**Proposition 4.6.** *Perfect positive correlation ( $\bar{\rho} = 1$ ) implies the conglomerate and its rivals evenly share each market ( $q_M^* = q_S^*$ ). If cash flow shocks are less than perfectly positively correlated ( $\bar{\rho} < 1$ ) equilibrium market shares of focused firms are strictly higher than shares of the conglomerate ( $q_S^* > q_M^*$ ).*

The negative real quantity effect caused by LL makes a conglomerate that competes with focused rivals less competitive in terms of market shares, that is, there is a strategic cost of diversification. In the terminology of Fudenberg and Tirole (1984), diversification involves a commitment to a relatively „soft stance“ in product markets. As the diversified firm tends to focus more on bad states of the world with low demand and high cost (relative to focused firms), it produces less output and therefore ends up with a smaller market share. In other words, if a coalition of unrelated focused firms chooses to merge, then the negative real quantity effect of this merger triggers a strategic output expansion of rival coalitions. Any decrease (increase) in the average correlation coefficient of shocks pushes the conglomerate’s reaction function downward (outward) and therefore decreases (increases) the conglomerate’s market share. Rivals react by expanding (contracting) output, which further depresses the conglomerate’s market share. This result complements findings of strategic costs of diversification in other settings (eg Lyandres, 2007).

### 4.4.3 Strategic Debt

Another stylized empirical fact is that diversified firms tend to have higher leverage ratios. For example, Denis et al. (2002) find that average leverage of industrially diversified firms is roughly 5 percentage points higher compared to more focused firms. Chkir and Cosset (2001) similarly find international and industrial diversification to be associated with higher leverage ratios than specialization. Again, such observations can be explained by a strategic cost of diversification that arises because of LL. If debt is a commitment to a tough stance on product markets, a diversified firm needs more debt to achieve the same „amount“ of commitment relative to focused rivals, since the negative financial synergy summoned by LL diminishes the effectiveness of strategic debt as a commitment device.

The theory of strategic debt dates back to Brander and Lewis (1986, BL in the following), who examine a risk-neutral two-stage duopoly model where two stand-alone firms with LL first simultaneously determine their leverage ratios and then compete in quantities in the product market. A brief account of the second stage is as follows. Stochastic ex post cash flow of firm  $j$  is  $\pi(q_j, q_{-j}, z_j)$  and depends on firm  $i$ ’s quantity  $q_j$ , on output  $q_{-j}$  of the other firm, and on the realization  $z_j$  of a zero-mean random shock

distributed on support  $(z_l, z^u)$  with distribution  $F(\cdot)$ . The firm has a nominal amount of outstanding debt  $D_j$  which is to be repaid after the cash flow has been revealed by nature. If profit exceeds  $D_j$ , then the firm is solvent and repays the full nominal amount of debt to creditors. If profit falls short of  $D_j$  the firm is bankrupt, and the payoff to owners is zero because of LL, while the creditor is entitled to any residual cash flow of the firm. Firm  $j$  chooses the quantity  $q_j$  that maximizes

$$\int_{\hat{z}_j}^{z^u} \{\pi(q_j, q_{-j}, z_j) - D_j\} dF(z_j), \quad (4.18)$$

where  $\hat{z}_j$  is the critical realization of the profit shock, determined by the implicit relation  $\pi(q_j, q_{-j}, \hat{z}_j) - D_j \equiv 0$ . The central insight of BL is that by increasing leverage firms may unilaterally commit to a higher quantity, because higher leverage allows the firm to focus on states with high demand and low cost, that is, unilateral increases in  $D_j$  increase equilibrium output  $q_j^*$  and decrease the competitor's output  $q_{-j}^*$ .

There is an apparent similarity between (4.18) and the objective function of a focused firm (4.3) above. A full-fledged analysis of diversification in a BL model — which is beyond the scope of this chapter and available from the author upon request — reveals that most insights developed in this chapter's analysis apply there as well. For example, assume there is a second unrelated duopoly market in the model of BL, and assume there is a single conglomerate merger of two firms. In terms of market shares, this merged firm needs more nominal debt to be competitive than the total nominal amount of debt used by its focused rivals. Put differently, if the diversified firm has exactly the same nominal amount of outstanding debt than the sum of its two focused rivals, then it produces less output in equilibrium, since its reaction function is strictly below the combined reaction function of its constituent stand-alone firms before the merger. Once again, this is because the single LL shelter available with diversification is less efficient than several market-specific shelters with specialization, and bad states of the world with low demand have consequently a greater impact on the output decision of the diversified firm. To avoid this strategic disadvantage, the diversified firm increases its leverage, which induces firm owners to focus more on good states of the world. Higher leverage ratios of diversified firms can thus be interpreted as attempts to avoid a strategic cost of diversification.

#### 4.4.4 Investment in R&D

There is some empirical evidence that large diversified firms invest relatively less in R&D than smaller focused firms (eg Denis et al., 2002). Along these lines, Baumol (2002, p21) argues „that most revolutionary new ideas have been, and are likely to continue to be, provided preponderantly by independent innovators“. Again, this stylized



fact can be explained by real effects of the negative financial synergy caused by LL.

Return to the alternative model introduced in the previous chapter, where R&D projects are either centralized within a single diversified firm or securitized in many stand-alone firms, and assume legal entities exhibit LL. The expected net market value (net of initial investment) of a representative securitized project  $S$  is

$$V_S = \int_0^{\infty} \lambda \theta \mu(x) dF(\theta) - x. \quad (4.19)$$

In terms of an imaginary “mean” project, the corresponding expected market value of centralized projects owned by a single diversified firm  $M$  is

$$V_M = n \left\{ \int_0^{\infty} \lambda \bar{\theta} \mu(x) dG(\bar{\theta}) - x \right\}, \quad (4.20)$$

where  $\bar{\theta}$  is the realization of the normally distributed mean shock to commercial values distributed with  $G(\cdot)$ , so that the difference in curly braces is the expected value of the „mean” project. A thorough examination of (4.19) and (4.20) yields the following results that are very similar to insights gathered in the merger model.

LL involves a positive investment distortion, firms invest more in R&D than with UL, since LL protects firm owners from damage claims of consumers: whereas UL implies that customers are compensated whenever an innovation turns out harmful ex post, LL means owners can simply abandon such projects and are shielded from compensation claims. Thus owners tend to focus on states of the world where marginal returns to investment in R&D are high. Moreover, there is a negative financial synergy associated with centralization of projects, that is, the expected difference between (4.20) and  $n$  times (4.19) is negative, and a portfolio of securitized projects is more valuable than a centralized portfolio. Just like in the merger model, the protection against bad states of the world is more comprehensive with decentralization of projects, as owners of projects are shielded from all negative commercial values of projects. Centralization instead means LL applies only in states of the world where the total commercial value of projects is negative. Since protection against damage claims is weaker with centralization, it follows that investment into each project is weaker as well. Negative states of the world, where innovations turn out harmful, receive more weight in the investment rationale with centralization. Expected welfare is maximized with a securitized project portfolio and LL. The relative reluctance of large diversified firms to invest in R&D might simply be a consequence of the legal organization of projects.

#### 4.4.5 Internalizing the Externality

In the previous analysis there was no systematic relationship between trade credit terms charged by upstream suppliers and downstream firm's liability status or product market behavior. Trade credit terms — as captured by the expected value of marginal cost  $c$  — were simply exogenous. Although this assumption is corroborated by empirical evidence, its relaxation has important consequences for the impact of UL and LL. More precisely, if each upstream supplier is able to set trade credit terms according to the specific borrowing quality and product market behavior of downstream firms, so that a supplier's expected payoff is always constant, there is no difference between UL and LL. Such pricing behavior induces internalization of the LL externality, and there are no financial synergies and no real effects.

To see this, consider the isolated vertical relationship between a single upstream supplier and a single focused stand-alone downstream firm in market  $i$ , an analysis inspired by Povel and Raith (2004). For simplicity, assume the upstream market is competitive. Furthermore, assume the downstream shock  $Z_i$  to the profit margin is caused by price uncertainty only. The downstream firm exhibits a one-to-one production technology, so one unit of a compound input is transformed into one unit of output (if the downstream firm wants to produce  $q_i$  units of output it therefore requires  $q_i$  units of input). The supplier sets a nominal price  $c$  for each unit of input he delivers to the downstream firm on trade credit terms, while his own constant marginal cost of production is  $\kappa$ , and there is no fixed cost. Because the upstream market is competitive, suppliers are required to break-even in equilibrium. While setting the nominal break-even price  $c$ , each supplier anticipates the expected effective value of the payment he will receive from the downstream firm at the end of the period, that is, the effective (and not nominal) value of the downstream firm's account payable to the supplier. From UL of the downstream firm follows immediately that in equilibrium  $c = \kappa$ , since the supplier always receives the full nominal value of the account payable.

This is different in case the downstream firm enjoys LL, where now two events may occur. Either the supplier receives the full nominal payment  $cq$  if the downstream firm is solvent ex post, an event that occurs with probability  $1 - F(\hat{z}_i)$ . Alternatively the downstream firm is bankrupt ex post with probability  $F(\hat{z}_i)$ , the supplier becomes the firm's new residual owner. Given a quantity  $q$  of delivered inputs, the break-even nominal price  $\hat{c}$  is therefore the solution to the implicit equation (the index  $i$  is again suppressed for simplicity)

$$\int_{-\infty}^{\hat{z}} \{p(q) + z\} q dF(\hat{z}) + [1 - F(\hat{z})] \hat{c} q = \kappa q, \quad (4.21)$$

where  $\hat{z}(\hat{c}) = \hat{c} - p(q)$ . The left hand side is the supplier's expected payment from

the downstream firm, consisting of the residual claim on revenue in case of the firm's bankruptcy (first term) and the full nominal payment  $cq$  in case the downstream firm is solvent (second term). The right hand side captures the supplier's own cost of production. Rearranging this expression for the equilibrium nominal price  $\hat{c}$  yields

$$\hat{c} = \frac{\kappa - \int_{-\infty}^{\hat{z}} \{p(q) + z\} dF(\hat{z})}{1 - F(\hat{z})}, \quad (4.22)$$

which has still  $\hat{c}$  on both sides, since  $\hat{z}$  depends on  $\hat{c}$ . The difference between the nominal price  $\hat{c}$  and the supplier's marginal cost  $\kappa$  captures the cost of trade credit financing, that is, the markup  $\hat{c} - \kappa$  can be interpreted as an interest rate that increases in the probability of the downstream firm's bankruptcy. Substitution of (4.22) into (4.3) yields the expected value  $V$  of a focused downstream firm with LL that sources from a supplier who charges break-even trade credit terms, contingent on the downstream firm's probability of bankruptcy and product market behavior:

$$V = \int_{-\infty}^{\hat{z}(\hat{c})} \{p(q) - \kappa + z\} q dF(z) + \int_{\hat{z}(\hat{c})}^{\infty} \{p(q) - \kappa + z\} q dF(z) = \{p(q) - \kappa\} q. \quad (4.23)$$

Even though the liability of the downstream firm is limited, there are no output distortions, and the firm produces benchmark output  $q^*$ . The only effect of the break-even nominal price  $\hat{c}$  is to determine the probability of the downstream firm's bankruptcy. Yet the downstream production decision is not affected by LL: firm owners attach the same weight to all states of the world, and equilibrium output is „efficiently“ governed by expected price and marginal cost of upstream production, there is no double marginalization. Although LL allows owners to externalize losses in case of bankruptcy, the supplier anticipates this effect and sets the nominal price of inputs so that the externality caused by LL is internalized through break-even trade credit terms. Thus there is no output distortion of LL in cases where upstream suppliers set input prices so that they always break-even in equilibrium. As there is no relation between the amount of risk and the expected market value and production quantities of firms, it follows there are no financial synergies and no real effects of a merger.

This extension highlights the importance of the reaction of stakeholders who are affected by LL, a notion that is often neglected in the literature on financial synergies, for example, by Sarig (1985). If passive stakeholders who are affected by LL can internalize the externality, then there is no difference between LL and UL regimes. This result formalizes an idea of Easterbrook and Fischel (1985) who argue that LL has no distorting impact on production if those who suffer from LL are allowed to internalize effects. Yet in the present model with trade credit such perfect price discrimination is

not plausible.<sup>8</sup>

## 4.5 Summary

This chapter examined financial synergies caused by LL. The externalization of risk associated with LL induces risk-neutral owners to produce more output, and this output distortion increases expected welfare as long as firms refrain from reckless behavior, and the distortion is strongest in particularly risky environments. A conglomerate merger causes a negative financial synergy, as the merger implies that market-specific LL shelters are abolished for a single aggregate shelter, so that protection against negative cash flows is less comprehensive with diversification. Most importantly, this means owners of diversified firms are more concerned with bad states of the world, they worry more about negative cash flows. Consequently diversified firms produce less output in equilibrium. A merger depresses equilibrium market values and production quantities as long as uncertainty in markets is to some degree market-specific (imperfect correlation).

These implications of LL depend very much on the internalization of the LL externality. If market-mechanisms establish perfect internalization, for example, through break-even trade credit terms, all effects of LL vanish. Without perfect internalization, corporate diversification is a commitment to a soft stance on product markets, both in simple Cournot games and in more complex strategic debt settings. This soft commitment establishes a strategic cost of diversification firms try to avoid, either by means of corporate specialization („structured finance”) or by other means („higher leverage”). All these results apply as well in the R&D model.

This completes the examination of the first synergy cause. A purely financial synergy caused by LL was shown to have real effects on output. Even though merging firms operate in completely unrelated product markets, the merger has negative consequences for consumers. This result stands in stark contrast to the conventional wisdom on diversification. Yet preferences of firm owners and consumers over corporate specialization and diversification are aligned, since both suffer from the merger.

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<sup>8</sup>Notice finally how this extension is related to the discussion of the financial crisis above. If buyers of securities would have been able to perfectly anticipate the risk-return profile of asset-backed securities, there would have been no real effects of financial synergies. Unfortunately, the limited ability of investors to correctly anticipate risk and return was another cause of the crisis.

## 4.6 Proofs

### Proposition 4.1

*Proof.* The first-order condition for expected cash flow that governs the benchmark quantity  $q^*$  is like (4.4) except that  $E[Z|z > \hat{z}]$  is replaced with  $E[Z] = 0$ . Hence  $q_S^* > q^*$  if and only if  $E[Z|Z > \hat{Z}] > E[Z] = 0$ . This is the case, since  $E[Z|z > \hat{z}]$  is strictly increasing in  $\hat{z}$ :

$$\frac{\partial E[Z|Z > \hat{z}]}{\partial \hat{z}} = \frac{f(\hat{z}) \int_{\hat{z}}^{\infty} \{z - \hat{z}\} dF(z)}{[1 - F(\hat{z})]^2} > 0,$$

where the integrand in the numerator is strictly positive ( $z \geq \hat{z}$  in the domain of integration in the numerator). Next note that  $E[Z|z > \hat{z}] = 0$  for  $\hat{z} = -\infty$ . It follows that  $E[Z|Z > \hat{z}] > 0$  for all values  $\hat{z} \in (-\infty, \infty)$  and thus  $q_S^* > q^*$ .  $\square$

### Proposition 4.2

*Proof.* The derivative of  $V_S^*$  with respect to  $\sigma$  is

$$\frac{dV_S^*}{d\sigma} = \frac{\partial V_S}{\partial \sigma} + \frac{\partial q_S^*}{\partial \sigma} V_S'.$$

The second term is zero since the first-order condition  $V_S' = 0$  is satisfied at  $q_S^*$  (the envelope theorem). The sign of  $(dV_S^*/d\sigma)$  is thus equal to the sign of

$$\frac{\partial V_S}{\partial \sigma} = f(\hat{z}) q_S^* \sigma,$$

which is clearly positive. Thus  $(dV_S^*/d\sigma) > 0$  in equilibrium.  $\square$

### Proposition 4.3

*Proof.* Implicit differentiation of first-order condition  $V_S' = 0$  yields

$$\frac{dq_S^*}{d\sigma} = - \frac{\left( \frac{\partial V_S'}{\partial \sigma} \right)}{V_S''}.$$

The denominator is negative since  $V_S$  is globally concave ( $V_S'' < 0$ ). Consequently, the sign of  $(dq_S^*/d\sigma)$  depends only on the sign of  $(\partial V_S'/\partial \sigma)$  in the numerator, which is

$$\text{sign} \left( \frac{\partial V_S'}{\partial \sigma} \right) = \text{sign} \left( \frac{\partial E[Z|Z > \hat{z}]}{\partial \sigma} \right)$$

because of the envelope theorem. Lemma (4.7) in section (4.7) establishes that  $(\partial E[Z|Z > \hat{z}]/\partial \sigma) > 0$  for all values of  $\hat{z}$ . Hence  $(\partial V_S'/\partial \sigma) > 0$  and therefore  $(dq_S^*/d\sigma) > 0$ .  $\square$

### Proposition 4.4

*Proof.* Notice  $\bar{\rho} = 1$  implies  $\sigma = \bar{\sigma}$  and therefore  $nV_S(q) = V_M(q)$  for all  $q$ , that is,

$$\int_{\hat{z}}^{\infty} n\pi(q, z)dF(z) = \int_{\hat{z}}^{\infty} n\pi(q, \bar{z})dG(\bar{z}),$$

since probability functions  $F(\cdot)$  and  $G(\cdot)$  are equivalent for  $\sigma = \bar{\sigma}$ . Thus for  $\bar{\rho} = 1$  market values with specialization and diversification always equal, and owners are indifferent between both options.  $\bar{\rho} < 1$  in turn implies  $\sigma > \bar{\sigma}$ , and one knows from proposition (4.2) that  $(\partial V_M^*/\partial \bar{\sigma}) > 0$ , which implies  $\Delta V < 0$  for  $\bar{\rho} < 1$ . Comparative statics of  $\Delta V$  follow a similar reasoning.  $\square$

### Proposition 4.5

*Proof.* It follows from proposition (4.4) that  $\bar{\rho} = 1$  implies  $\sigma = \bar{\sigma}$  and thus  $q_M^* = q_S^*$ . Proposition (4.3) implies that  $(dq_M^*/d\bar{\sigma}) > 0$ , so that for any  $\bar{\rho} < 1$  there is  $\sigma > \bar{\sigma}$  and thus  $q_M^* < q_S^*$ . Since  $(\partial \bar{\sigma}/\partial \bar{\rho}) > 0$  it follows that  $(q_M^*/\partial \bar{\rho}) > 0$ .  $\square$

### Proposition 4.6

*Proof.* It follows from proposition (4.5) that at  $\bar{\rho} = 1$  equilibrium quantities of specialized and diversified firms are identical ( $q_S^* = q_M^*$ ), since the objective function of the conglomerate (4.17) equals the objective function of each focused firm (4.16), except for multiplication by a constant. Total differentiation of the system of first-order conditions, subsequent division of the result by  $d\bar{\rho}$ , restatement in matrix notation and application of Cramer's rule yields

$$\begin{aligned} \frac{\partial q_M^*}{\partial \bar{\rho}} &= -\frac{V_{M\bar{\rho}}^M V_{SS}^S}{H} > 0, \\ \frac{\partial q_S^*}{\partial \bar{\rho}} &= \frac{V_{M\bar{\rho}}^M V_{SM}^S}{H} < 0, \end{aligned}$$

since  $H = V_{MM}^M V_{SS}^S - V_{SM}^S V_{MS}^M > 0$  is the usual Cournot stability condition (downward sloping reaction functions),  $V_{M\bar{\rho}}^M > 0$  (see proposition 4.5),  $V_{SS}^S < 0$  (second-order condition) and  $V_{SM}^S < 0$  (quantities are strategic substitutes). Therefore, if  $\bar{\rho} < 1$  then  $q_S^* > q_M^*$ .  $\square$

## 4.7 Conditional Expectations

This section establishes a property of conditional expectations of normally distributed random variables.

**Lemma 4.7.** *Let  $x$  denote the realization of a normally distributed random variable  $X$  with expected value  $E[X] = 0$ , standard deviation  $\sigma_X$  and probability density function  $h(x)$ . For all  $\hat{x} \in \mathbb{R}$  the conditional expected value of  $X$ , conditional on the event that  $X > \hat{x}$ , increases in the standard deviation of  $X$ , that is*

$$\frac{\partial E[X|X > \hat{x}]}{\partial \sigma_X} > 0.$$

*Proof.* First recall a standard result from probability theory (see e.g. Johnson et al., 1994, p156). The conditional expected value of a normally distributed random variable  $X$  with zero expected value and constant standard deviation  $\sigma_X$  is

$$E[X|X > \hat{x}] = \frac{\int_{\hat{x}}^{\infty} xh(x)dx}{1 - \int_{-\infty}^{\hat{x}} h(x)dx} = \frac{\phi(\tau)}{1 - \Phi(\tau)}\sigma_X,$$

where  $\phi(\cdot)$  is the standard normal probability density function,  $\Phi(\cdot)$  the standard normal cumulative density and  $\tau = \hat{x}/\sigma_X$  the normalized value of realization  $\hat{x}$ . The partial derivative of  $E[X|X > \hat{x}]$  with respect to the standard deviation of  $X$  is then

$$\frac{\partial E[X|X > \hat{x}]}{\partial \sigma_X} = \frac{\phi(\tau)[1 - \Phi(\tau)] - \tau[\partial\phi(\tau)/\partial\tau][1 - \Phi(\tau)] - \tau[\phi(\tau)]^2}{[1 - \Phi(\tau)]^2}.$$

Since the denominator of this expression is positive for all values of  $\hat{x}$  the lemma is true by if the numerator is as well positive for all values of  $\hat{x} \in \mathbb{R}$ . For *non-positive* values of  $\hat{x}$  (that is,  $-\infty < \tau \leq 0$ ) all terms in the numerator are positive (recall that  $\partial\phi(\tau)/\partial\tau > 0$  for  $\tau < 0$ ) and the lemma is consequently true. To see that the lemma holds as well for *positive* values of  $\hat{x}$  (that is,  $0 < \tau < \infty$ ) first substitute the explicit expressions for the standard normal density and standard normal cumulated density functions and multiply the numerator by  $4\pi^{(3/2)} \exp(-\tau^2)^{-1}$ . Finally rearrange terms to see that the numerator is positive if and only if

$$\sqrt{\frac{\pi}{2}} \exp\left(\frac{\tau^2}{2}\right) \operatorname{erfc}\left(\frac{\tau}{\sqrt{2}}\right) > \frac{\tau}{\tau^2 + 1},$$

where  $\operatorname{erfc}(u) = (2/\sqrt{\pi}) \int_u^{\infty} e^{-t^2} dt$  is the so called complementary error function. The left hand side of this expression can be expressed conveniently as a continued fraction

(see e.g. Spanier and Oldham, 1987, p399):

$$\sqrt{\frac{\pi}{2}} \exp(v) \operatorname{erfc}(\sqrt{v}) = \frac{1}{\sqrt{2v+}} \frac{1}{\sqrt{2v+}} \frac{2}{\sqrt{2v+}} \frac{3}{\sqrt{2v+}} \frac{4}{\sqrt{2v+}} \dots$$

where  $v \equiv \tau^2/2 \equiv \hat{x}^2/(2\sigma_X^2)$ . Hence we finally find that

$$\sqrt{\frac{\pi}{2}} \exp\left(\frac{\tau^2}{2}\right) \operatorname{erfc}\left(\frac{\tau}{\sqrt{2}}\right) = \frac{1}{\tau + \frac{1}{\tau+\dots}} > \frac{1}{\tau + \frac{1}{\tau}} = \frac{\tau}{\tau^2 + 1}.$$

It follows that the numerator of  $(\partial E[X|X > \hat{x}]/\partial \sigma_X)$  is positive for all  $\hat{x} \in (-\infty, \infty)$ .  $\square$



# Chapter 5

## Distress Costs

*To Mercy, Pity, Peace, and Love  
All pray in their distress;  
And to these virtues of delight  
Return their thankfulness.*

— William Blake in *The Divine Image*

### 5.1 Introduction

Distress costs (DC) are financial costs that arise only if the value of a firm's assets falls below a critical threshold. A familiar special case of DC are direct and indirect costs of bankruptcy, which occur only if the value of assets falls below the threshold that triggers default, often the nominal value of outstanding debt. Bankruptcy costs capture the impaired ability to do business due to customers' concerns for the firm's survival, interruptions or cancellations if the firm files for bankruptcy, distressed asset fire-sales, employees leaving the firm or spending their time looking for another job, and management spending much of its time talking to creditors and investment bankers about reorganization and refinancing plans instead of running the business. Bankruptcy costs can be substantial: Altman and Hotchkiss (2006) and Branch (2002) survey the empirical literature and conclude they amount on average to about 20% of a firm's asset value.

This chapter examines financial synergies caused by a closely related kind of DC that arise whenever a firm's cash flow falls below the critical value of zero, in other words, distress costs associated with negative firm performance. There is a plethora of causes for such costs. For example, if negative cash flow is perceived as a signal of low management quality by outsiders, DC can be interpreted as the monetarized value of the total damage to the reputation of owner-managers. Alternatively, in case employees, suppliers and customers worry over a firm's prospects and likelihood of

survival, or if distress causes tedious discussions over the causes of negative performance that divert management attention from day-to-day operations, then DC capture opportunity costs of such frictions. In cases where a negative cash flow is a shut-down condition, associated costs of closing the firm can be interpreted as DC as well, for example, legal fees for trustees, lawyers and liquidation, the costs of bargaining with employees, unions, suppliers and customers over the resolution of unsettled contractual obligations and so forth. Overall, anecdotal evidence provided by managers and business practitioners emphasizes the distinct bad taste of negative firm performance.

To make the notion of such DC formally, let  $y \in \mathbb{R}$  again denote the ex post value of a firm's assets, which is the total cash flow of a firm in the merger model that was introduced in chapter 3. Assume ex post DC of a firm that owns and operates  $m \leq n$  business units are

$$d = \begin{cases} 0 & \text{if } y \geq 0 \\ m\bar{D} & \text{if } y < 0 \end{cases}, \quad (5.1)$$

where  $\bar{D} > 0$  is a positive and fixed exogenous distress cost per business unit.<sup>1</sup> Thus, if the ex post value of cash flow is negative ( $y < 0$ ) owners face costs of distress  $m\bar{D}$ , and if ex post cash flow is positive ( $y \geq 0$ ) there are zero DC. Assuming unlimited liability, it follows that the valuation function  $v(y)$  that relates the value of assets to a firm's market value is

$$v(y) = \begin{cases} y & \text{if } y \geq 0 \\ y - m\bar{D} & \text{if } y < 0 \end{cases} \quad (5.2)$$

in this chapter. In the complete absence of DC ( $\bar{D} = 0$ ) the valuation function reduces to  $v = y$ . The function (5.2) is non-decreasing in  $y$  and invariant to the scale of firms, as the value of DC is strictly proportional to the number of markets a firm operates in. Valuation functions for zero and positive DC are depicted in figure 5.1. DC clearly drive a financial wedge between the value of assets and a firm's market value, which suggests they summon financial synergies. Notice how the valuation function with positive DC is neither convex nor concave.

As was already explained in the primer on synergies, DC can cause positive financial synergies if diversification reduces the probability of distress and therefore the total expected value of DC (Scott, 1977; Leland, 2007). Such synergies often serve as justification for diversifying mergers and corporate diversification (Lubatkin and Chatterjee, 1994). Unfortunately, the analysis in this chapter suggests that real effects of positive financial synergies caused by DC can harm consumers. While a strictly lower cumulative probability of distress with diversification causes positive financial synergies,

<sup>1</sup>Equation (5.1) is just one of many possible DC functions. Alternative specifications, where DC are proportional to the ex post value of assets, or where distress is triggered by arbitrary cash flow values, are examined in section (5.6).

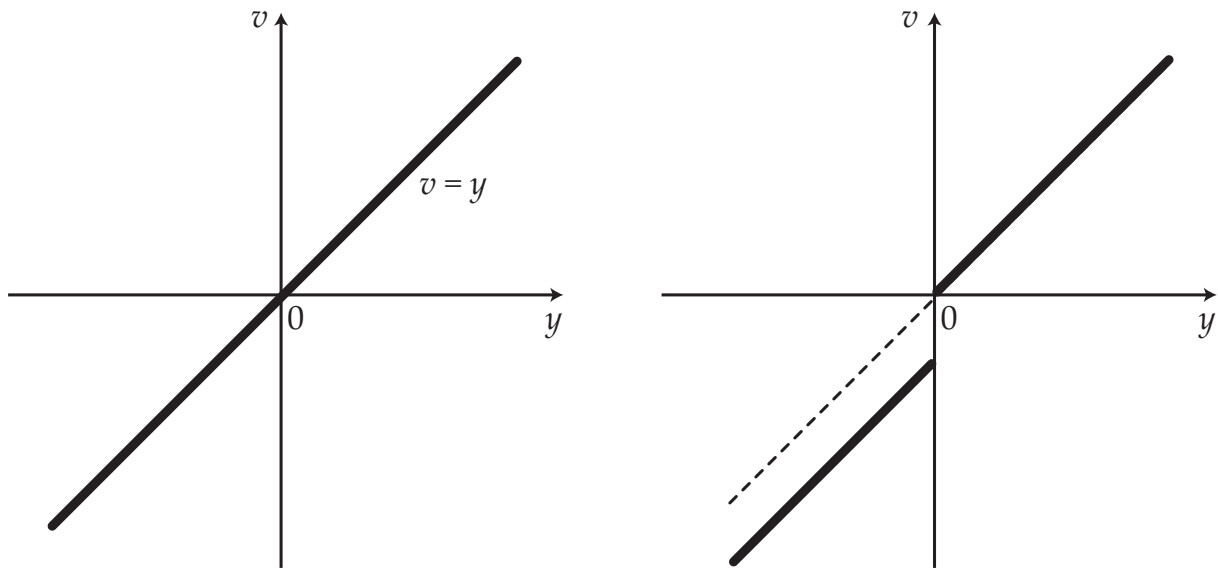


Figure 5.1: The relation between the ex post value of a firm's assets  $y$  and its ex post market value  $v$  for  $\bar{D} = 0$  (left) and  $\bar{D} > 0$  (right). Along the dashed line  $v = y$ . The vertical distance between the dashed and the solid line in the right figure captures the value of DC in state  $y$  of the world.

there is a real quantity effect of synergies that depends on the marginal probability of distress, and this marginal probability can both increase and decrease because of diversification. More precisely, in a low-risk product market environment output increases if firms merge, so that corporate diversification is a Pareto-improvement, a free lunch. But in a high-risk environment, where incentives to merge are greatest because of overall high expected DC, output in fact decreases after a merger. In this case positive financial synergies harm consumers, a finding which makes fixed DC as given by (5.1) one of the more problematic causes of financial synergies examined in this thesis.

Like in the previous chapter, section 5.2 first examines the basic output distortion associated with DC. Section 5.3 then examines financial synergies and their real quantity effects. Section 5.4 presents applications and extensions, and section 5.5 summarizes findings.

## 5.2 Output Distortions

Since DC arise only in states of the world where a firm's cash flow is negative, firms should have an incentive to avoid such states by choosing relatively „cautious” product market strategies. This section examines such output distortions caused by DC. Since markets are perfectly symmetric, the analysis focuses again without loss of generality on a single representative stand-alone firm  $S$  in market  $i$ , where the index  $i$  is omitted in the following. Just like in the previous chapter, all results apply qualitatively to the diversified firm  $M$  as well.

Since firm  $S$  is engaged in a single product market ( $m = 1$ ), it follows from equation (5.1) that its DC function is

$$D_S = \begin{cases} 0 & \text{if } \pi(q, Z) \geq 0 \\ \bar{D} & \text{if } \pi(q, Z) < 0 \end{cases}. \quad (5.3)$$

The firm chooses a quantity that maximizes its expected market value  $V_S$ , which is according to (5.2) equal to the difference between the expected value of its cash flow and the expected value of (5.3), that is, the firm solves

$$\max_q V_S = \int_{-\infty}^{\infty} \pi(q, z) dF(z) - E[D_S], \quad (5.4)$$

where  $E[D_S]$  is the expected value of (5.3). To derive the associated first-order condition, expected DC are reformulated in terms of the critical realization  $\hat{z} = c - p(q)$  of shock  $Z$  at which the representative firm's cash flow is exactly zero and the firm just on the verge of distress. In all states of the world where  $z > \hat{z}$  ex post, revenue exceeds costs and cash flow is positive, while for  $z < \hat{z}$  costs exceed revenue and firm performance is negative. Notice how the probability of distress  $F(\hat{z})$  can never exceed 0.5, since  $p(q) > c$  and therefore  $\hat{z} < 0$  in equilibrium. Otherwise,  $\hat{z} > 0$  would imply that expected cash flow is negative, in which case risk-neutral owners prefer to do no business at all in equilibrium. The probability of distress increases both in the level of output and in the expected value of marginal cost, since  $(\partial \hat{z} / \partial q) > 0$  and  $(\partial \hat{z} / \partial c) > 0$ . In terms of  $\hat{z}$ , expression (5.3) can be equivalently stated as

$$D_S = \begin{cases} 0 & \text{if } Z \geq \hat{z} \\ \bar{D} & \text{if } Z < \hat{z} \end{cases}, \quad (5.5)$$

so the expected value of DC in (5.4) is  $E[D_S] = F(\hat{z})\bar{D}$ . Throughout the chapter, let  $V' \equiv (\partial V / \partial q)$  denote the first and  $V'' \equiv (\partial^2 V / \partial q^2)$  the second derivative of  $V$  with respect to  $q$ . The first-order condition of problem (5.4) is  $V'_S = 0$ , and the second-order condition  $V''_S < 0$  is always satisfied since  $V_S$  is concave in output.<sup>2</sup> The equilibrium quantity  $q_S^*$  solves

$$V'_S = \frac{\partial p(q)}{\partial q} q + p(q) - \left( c + \frac{\partial \hat{z}}{\partial q} f(\hat{z}) \bar{D} \right) = 0. \quad (5.6)$$

<sup>2</sup>To see that  $V_S$  is globally concave, let  $p' \equiv (\partial p(q) / \partial q) < 0$  and  $p'' \equiv (\partial^2 p(q) / \partial q^2) < 0$ . The second derivative of  $V_S$  with respect to  $q$  is

$$V''_S = 2p' + qp'' + \left\{ \hat{z}(p')^2 + \sigma^2 p'' \right\} \sigma^{-1} f(\hat{z}) \bar{D}.$$

Since  $\hat{z} < 0$ , this expression is strictly non-positive and the problem of the firm thus globally concave in output.

The first two terms summarize expected marginal revenue. The sum in parenthesis captures total expected marginal cost, which consist of two parts for  $\bar{D} > 0$ : marginal cost of production ( $c$ ) and marginal cost of distress, that is, the marginal change in  $E[D_S]$  given by the second term in parenthesis. Let  $q_S^*$  be the solution to (5.6).<sup>3</sup> Recall  $q^*$  is the benchmark quantity that maximizes expected cash flow in product market  $i$  gross of distress costs, that is, the quantity that solves (5.6) for  $\bar{D} = 0$ . The following proposition compares  $q^*$  and  $q_S^*$ . Proofs of propositions can be found at the end of the chapter in section 5.6.

**Proposition 5.1.** *With positive DC the representative firm produces strictly less in equilibrium than the quantity that maximizes expected cash flow, that is,  $\bar{D} > 0$  implies  $q_S^* < q^*$ , whereas  $\bar{D} = 0$  implies  $q_S^* = q^*$ . Equilibrium output of the representative stand-alone firm is strictly decreasing in the amount of DC, that is,  $(dq_S^*/d\bar{D}) < 0$ .*

DC generally have a depressing impact on output. Technically, if  $\bar{D} > 0$  marginal distress costs are always positive and total marginal costs therefore strictly higher than with  $\bar{D} = 0$ . At the benchmark quantity  $q^*$  the first-order condition (5.6) is thus negative if  $\bar{D} > 0$ , and starting at  $q^*$ , output needs to decrease to achieve equilibrium. More intuitively, firms produce less output to reduce the likelihood of negative cash flow. This underinvestment result is often obtained in models that link DC to product market and investment behavior, for example, in models of Brander and Lewis (1988) and Povel and Raith (2004).

The output distortion suggests costs of distress have not only direct but as well indirect consequences for expected welfare. First of all, holding output constant, there is the direct impact of DC on the market value of each firm, which concerns only firm owners. In addition, there is an indirect effect since consumers suffer from lower output and higher expected prices. Even though consumers are not directly affected by DC, they are indirectly concerned because of the associated output distortion. The overall impact of DC on expected welfare in  $n$  markets with stand-alone firms is

$$-n \left( E[D_S] + \int_{q_S^*}^{q^*} \{p(t) - c\} dt \right) < 0. \quad (5.7)$$

The first term in parenthesis captures the direct impact of DC on market values of focused firms, while the second term is the indirect welfare loss caused by the output distortion. Since both terms in parenthesis are positive, the overall effect of DC is strictly negative. Notice that as the amount of distress cost per market  $\bar{D}$  increases, both direct and indirect effects increase as well.

Consider now comparative statics of firm behavior, commencing with changes in the standard deviation of shocks. Let  $V_S^* \equiv V_S(q_S^*)$  be the expected equilibrium market

<sup>3</sup>Uniqueness of  $q_S^*$  follows directly from the global concavity of  $V_S$ .

value of firm  $S$ , that is, the expected value of  $V_S$  at the optimal level of output  $q_S^*$ .

**Proposition 5.2.** *The expected equilibrium market value of the representative firm is strictly decreasing in the standard deviation of the cash flow shock, that is,  $(dV_S^*/d\sigma) < 0$ .*

Intuitively, more uncertainty decreases the expected market value of firms because the probability of distress and therefore expected cost of distress both increase as the standard deviation of shocks rises. Increases in risk have unambiguous and straightforward implications for firm owners. The left part of figure 5.2 graphs an example of the monotonic relation between the equilibrium market value and the standard deviation of shocks. But what about consumers? The quantity effect of changes in  $\sigma$  depends on the risk-type of the product market. There are two types:

**Definition.** In a low-risk (high-risk) product market, the equilibrium probability of distress  $F(\hat{z})$  is smaller (greater) than  $F(-\sigma) \approx 0.16$ .

The high- or low-risk nature of any given product market depends mainly on the standard deviation of the related cash flow: if this standard deviation is high relative to expected cash flow, that is, if cash flow exhibits a high coefficient of variation, then the market is likely of a high-risk type, and vice versa for a low-risk market. The motivation for this distinction between low-risk and high-risk types is the reaction of the marginal probability of distress to changes in the variability of cash flow, which is decisive for the analysis in this chapter. Given this definition of high- and low-risk markets, the next proposition summarizes comparative statics of equilibrium output in terms of the risk-type of product markets. It is one of the central results of this chapter.

**Proposition 5.3.** *Equilibrium output of the representative firm is a U-shaped function of the standard deviation of the cash flow shock: In low-risk (high-risk) product markets output is locally decreasing (increasing) in  $\sigma$ .*

This novel result is decisive for the analysis of financial synergies in the following section, as it indicates that diversification — which is ultimately reduction of relative risk — may have ambiguous output effects. First-order condition (5.6) clearly shows that the reaction of equilibrium quantities to changes in the riskiness of cash flow depends on the marginal probability of distress. This marginal probability reacts in a non-monotonic fashion to changes in risk, it may both rise or fall as risk increases, a natural property of the normal distribution. In low-risk (high-risk) markets marginal DC increase (decrease), so that output decreases (increases). The right part of figure 5.2 depicts the U-shaped relation between  $q_S^*$  and  $\sigma$ . For low levels of  $\sigma$  output is locally decreasing in risk, arrives at a minimum, and rises again. Notice that for extremely low and extremely high values of  $\sigma$  output approaches the benchmark level  $q^*$ , since the marginal probability of distress approaches zero, so DC do not matter much for output if distress is either impossible or nearly certain.

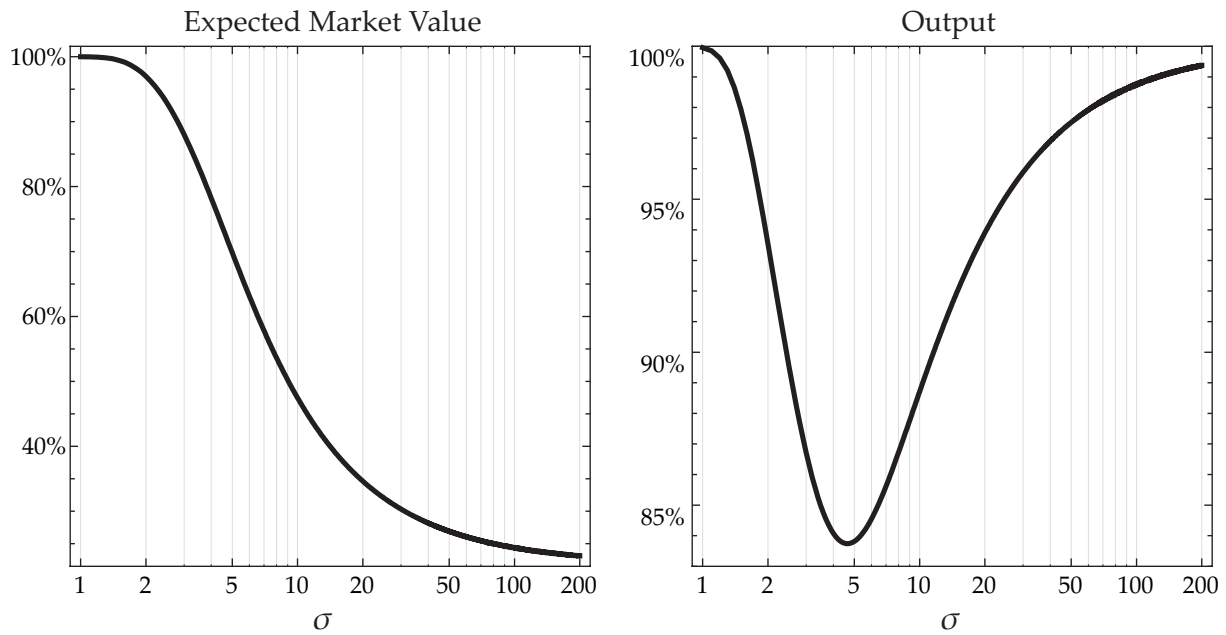


Figure 5.2: Numerical example with linear expected inverse demand  $p(q) = 10 - q$ , expected marginal cost  $c = 2$  and distress cost per market  $\bar{D} = 25$ . Equilibrium market value  $V_S^*$  (left) and output  $q_S^*$  (right) of the representative firm  $S$  as a function of  $\sigma$  on a log-linear scale, in percent of equilibrium market values and quantities with zero DC ( $\bar{D} = 0$ ).

There are several models where U-shaped equilibrium output or investment can be reinterpreted in the spirit of proposition 5.3. For example, Brander and Lewis (1988) find that output is a U-shaped function of a firm's leverage ratio if firms face positive bankruptcy costs, a result that is very much related to the present analysis since the leverage ratio indirectly determines the probability of bankruptcy and distress. Similarly, Povel and Raith (2004) arrive at U-shaped output as a function of the level of internal funds available to a firm, which similarly determines the amount of necessary external capital and therefore the likelihood of bankruptcy.

Together propositions 5.2 and 5.3 imply that consumers and firm owners can have opposing preferences over changes in the riskiness of cash flow. Owners always prefer less to more risk, since expected DC decrease if risk decreases. This is the reverse of the previous chapter, where firm owners strictly benefited from increases in risk. Preferences of consumers in turn depend on implications for equilibrium quantities. In low-risk markets consumers prefer less to more risk because output decreases in the amount of uncertainty, and vice versa in high-risk markets. Yet both consumers and producers would prefer a setting without risk, where expected DC would be zero, so that firms produce the benchmark quantity that maximizes expected operating cash flow.

### 5.3 Real Effects of Financial Synergies

A diversified firm often exhibits lower expected costs of distress than a comparable set of focused firms. This section examines such financial synergies and their real effects. If  $V_S^*$  is the expected equilibrium market value of a representative focused firm  $S$ , and  $V_M^*$  the respective value of the conglomerate, then the expected value of financial synergies is

$$\Delta V \equiv V_M^* - nV_S^*. \quad (5.8)$$

As  $V_S^*$  was already examined in the previous section, it remains to derive  $V_M^*$ . According to (5.1), the DC function of a conglomerate with  $n$  business units is

$$D_M = \begin{cases} 0 & \text{if } \sum_{i=1}^n \pi(q, Z_i) \geq 0 \\ n\bar{D} & \text{if } \sum_{i=1}^n \pi(q, Z_i) < 0 \end{cases}. \quad (5.9)$$

The problem of firm  $M$  is to choose a vector of quantities  $\mathbf{q} = \{q_1, \dots, q_n\}$  that maximizes its expected market value  $V_M$ , which is equal to the difference between total expected cash flow of its  $n$  business units and total expected costs of distress, that is, to solve

$$\max_{\mathbf{q}} V_M = \sum_{i=1}^n \int_{-\infty}^{\infty} \pi(q_i, z_i) dF(z_i) - E[D_M], \quad (5.10)$$

where  $E[D_M]$  is the expected value of (5.9). Perfect symmetry of markets allows without loss of generality to focus on symmetric equilibrium quantities, so assume  $q_i = q$  for all  $i \in N$ . Just like in the previous chapter, problem (5.10) can be expressed in terms of a single average product market that is representative for the diversified firm's portfolio of business units (readers not familiar with this approach should consult section 4.3 in the previous chapter). This average product market depends on the realization  $\bar{z}$  of the mean cash flow shock  $\bar{Z} = \sum Z_i/n$ , which is normally distributed with distribution function  $G(\bar{z})$ , expected value zero and standard deviation  $\bar{\sigma}$ . Its standard deviation depends on the variance-covariance structure of the  $n$  shocks, which is summarized by the average coefficient of correlation  $\bar{\rho}$ . In the limiting case where all shocks are perfectly positively correlated ( $\bar{\rho} = 1$ ) the mean shock is exactly distributed as each single shock ( $\bar{\sigma} = \sigma$ ). Generally, imperfect correlation of shocks implies there is less uncertainty in the average market than in each individual market. Similar to its total cash flow, costs of distress can be expressed in terms of the representative product market as well. Let  $\hat{z} \equiv c - p(q)$  be the critical realization of the mean shock at which total cash flow of firm  $M$  equals zero. Whenever  $\bar{z} \geq \hat{z}$  total cash flow is positive and there are no distress costs, and in case  $\bar{z} < \hat{z}$  aggregate cash flow is negative and distress



costs are positive. Expression (5.9) is thus equivalent to

$$D_M = \begin{cases} 0 & \text{if } \bar{Z} \geq \hat{z} \\ n\bar{D} & \text{if } \bar{Z} < \hat{z} \end{cases}. \quad (5.11)$$

The expected value of firm  $M$ 's DC is therefore  $E[D_M] = G(\hat{z})n\bar{D}$ . Finally, a much more convenient formulation of problem (5.10) in terms of the representative market is

$$\max_q! \quad V_M = n \left[ \int_{-\infty}^{\infty} \pi(q, \bar{z}) dG(\bar{z}) - G(\hat{z})\bar{D} \right], \quad (5.12)$$

where the first term in brackets is expected cash flow in the representative market, and the second expected average DC per market. The first-order condition of this problem is  $V'_M = 0$ . The second-order condition  $V''_M < 0$  is satisfied since  $V_M$  is globally concave. The optimal quantity  $q_M^*$  solves

$$V'_M = n \left[ \frac{\partial p(q)}{\partial q} q + p(q) - \left( c + \frac{\partial \hat{z}}{\partial q} g(\hat{z})\bar{D} \right) \right] = 0, \quad (5.13)$$

which is very similar to the first-order condition of a representative focused firm (5.6). Comparative statics derived above in the context of focused firm therefore apply as well to the conglomerate. Explicitly, let  $q_M^*$  denote equilibrium output and  $V_M^* \equiv V_M(q_M^*)$  the equilibrium market value of firm  $M$ . Equilibrium output decreases in the value of distress costs (see proposition 5.1). The impact of marginal changes in  $\bar{\sigma}$  on output depends on the risk-type of the conglomerate's representative product market: if the representative market is of a low-risk (high-risk) type, firm output locally decreases (increases) in risk, so that output is a U-shaped function of riskiness in the average market (see proposition 5.3).

Expected total market values  $nV_S^*$  and  $V_M^*$  determine the expected value of financial synergies, while real effects depend on equilibrium quantities  $q_S^*$  and  $q_M^*$ . The following proposition first establishes a condition for the absence of synergies and real effects.

**Proposition 5.4.** *If shocks are on average perfectly positively correlated, then there are no financial synergies and no quantity effects of a merger, that is, if  $\bar{\rho} = 1$  then  $\Delta V = 0$  and  $q_S^* = q_M^*$ .*

Just like in the previous chapter, a conglomerate merger of focused firms with perfectly positively correlated cash flows does not summon any financial synergy. Perfect positive correlation of cash flows — for example, if uncertainty is purely systemic or macroeconomic and not market-specific — implies there is no risk-reduction associated with diversification, and total expected costs of distress are not affected by a merger. More technically, if shocks are perfectly positively correlated the mean cash flow shock

$\bar{Z}$  that characterizes the diversified firm's representative product market has exactly the same distribution as each single shock  $Z$ . The product market of each focused firm and the representative product market of the conglomerate are thus equivalent in expected terms, and decision problems of firms  $S$  and  $M$  equal, that is, (5.12) is equivalent to (5.4), except for multiplication by  $n$  (which has no impact on output decisions). Consider next the empirically most relevant case of imperfectly correlated markets.

**Proposition 5.5.** *If shocks are on average imperfectly correlated, then there are positive financial synergies, that is, if  $\bar{\rho} < 1$  then  $\Delta V > 0$  in equilibrium. The expected value of synergies decreases in the average correlation coefficient, that is,  $(\partial \Delta V / \partial \bar{\rho}) < 0$ .*

A merger of firms with imperfectly correlated cash flows reduces total expected distress costs, and the value of financial synergies equals the difference between total expected DC after and before the merger. The distribution of firm  $M$ 's total cash flow is more concentrated around its mean, so the probability of negative cash flow values is relatively lower, a result perfectly in line with the notion that diversification „smooths“ a firm's cash flow and „reduces risk“. It supports earlier findings by Scott (1977) and Yagil (1989) who similarly argue that diversification often reduces expected distress cost. Technically, imperfect correlation of shocks means the standard deviation of the mean shock in firm  $M$ 's representative market is strictly lower than the standard deviation of each market-specific shock. Proposition 5.2 established that in the presence of DC firms become more valuable as the riskiness of their assets and therefore the expected value of DC decreases, hence risk-reduction associated with diversification causes a positive financial synergy. The left part of figure 5.3 graphs financial synergies in a numerical example. On the vertical axis is the equilibrium market value of the merged firm in percent of the total expected value of focused firms. Notice how synergies are positively related to the riskiness in the environment. Synergies can be quite significant: a merger of firms with uncorrelated cash flows in a high-risk environment increases their total expected market value by 20%.

Consider now quantity effects of financial synergies, which concern consumers and competition authorities. Intuitively, one expects consumers should not suffer from diversification of firms in this model, as the unrelatedness of markets implies there are no market power effects of the conglomerate merger. As the diversified firm enjoys lower expected costs of distress, one could even presume that consumers should somehow benefit from the efficiency enhancing merger. Yet recall that proposition 5.3 established that output reacts in a non-monotonic and counter-intuitive way to changes in risk. The following proposition provides sufficient conditions for a welfare-improving conglomerate merger:

**Proposition 5.6.** *If product markets are of a low-risk type, and if shocks are imperfectly correlated, then corporate diversification strictly increases equilibrium output of firms, that is,*

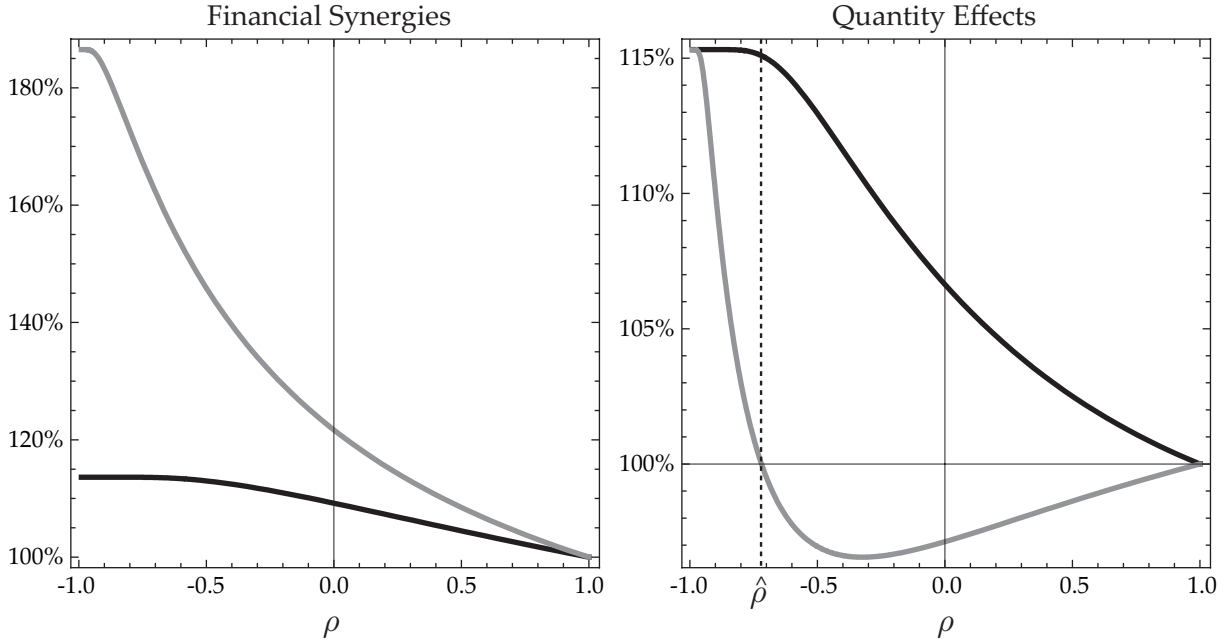


Figure 5.3: Numerical example with two markets ( $n = 2$ ), linear expected inverse demand  $p(q) = 10 - q$ , expected marginal cost  $c = 2$  and distress cost  $\bar{D} = 25$ . The left figure graphs  $V_M^*$  in percent of  $nV_S^*$  as a function of the correlation coefficient  $\rho$ . The right figure graphs  $q_M^*$  in percent of  $q_S^*$ , again as a function of  $\rho$ . In both figures the black schedule refers to a low-risk environment ( $\sigma = 3$ ) and the gray schedule to a high-risk environment ( $\sigma = 8$ ).

$F(\hat{z}) < F(-\sigma)$  and  $\bar{\rho} < 1$  together imply  $q_S^* < q_M^* < q^*$ .

The merger is therefore a Pareto-improvement in low-risk markets, since both firm owners and consumers benefit from diversification. Diversification strictly reduces marginal costs and therefore induces an expansion of output. Once more, the intuition for this result is best explained with reference to firm  $M$ 's representative market. Proposition 5.3 established that in a low-risk environment output of focused firms strictly increases as the standard deviation of shocks decreases. With less than perfectly positively correlated shocks there is strictly less risk in the representative product market than in each single market, which means the representative market is of a low-risk type as well. Hence the diversified firm produces more output than focused firms. For example, a cross-border merger that involves low-risk countries (for example, Germany and France) should have strictly positive implications for consumers. This is different if markets are of a high-risk type.

**Proposition 5.7.** *If product markets are of a high-risk type, there exists a critical value  $\hat{\rho} < 1$  of the average correlation coefficient at which a conglomerate merger has no quantity effect. If the actual average correlation coefficient  $\bar{\rho}$  is greater (smaller) than this critical value  $\hat{\rho}$ , a merger decreases (increases) equilibrium output of firms, that is, for  $F(\hat{z}) > F(-\sigma)$  the output effect*

of the merger is

$$\begin{aligned}\bar{\rho} = \hat{\rho} &\implies q^* > q_S^* = q_M^*, \\ \bar{\rho} > \hat{\rho} &\implies q^* > q_S^* > q_M^*, \\ \bar{\rho} < \hat{\rho} &\implies q^* > q_M^* > q_S^*.\end{aligned}$$

This proposition is another novel result of this thesis: If unrelated firms engage in a diversifying merger to benefit from an endogenous financial synergy, then real effects of this merger can harm consumers, even though there are absolutely no operational synergies with redistributive consequences, as, for example, anti-competitive practices. More precisely, a merger of firms who exhibit very risky and highly correlated cash flows is likely to reduce output and therefore to diminish expected surplus of consumers. Only with sufficiently low average correlation of cash flows both consumers and producers benefit. This follows from the U-shaped relation between output and risk. In a high-risk environment marginal distress cost rise as the standard deviation of cash flows decreases, which results in lower output. If cash flows in such high-risk product markets are highly positively correlated, then the conglomerate's representative product market is of a high-risk type as well, so that output decreases because of the merger's risk-reduction effect. Only if cash flows are sufficiently negatively correlated the representative market is of a low-risk type, so that output increases as risk decreases. Empirically, a cross-border merger involving countries with very risky and highly correlated economies — think of neighboring developing countries like Chad and Sudan — is likely to decrease output. But a similar merger that involves distant developing countries like Chad and Columbia can be expected to have positive implications for consumers because of higher output in both countries.

The right part of figure 5.3 graphs quantity effects for a numerical example. On the vertical axis is equilibrium output of firm  $M$  in percent of output of firm  $S$ . Generally, with perfectly correlated shocks there is no quantity effect, irrespective of the risk-type of markets. If shocks are imperfectly correlated a merger strictly increases output in a low-risk environment, as captured by the black schedule. But in a high-risk environment (the gray schedule) a merger depresses output for  $\rho > \hat{\rho} \approx -0.7$  and increases output for  $\rho < \hat{\rho}$ . The worst case scenario is a product market environment with  $\rho \approx -0.4$ , where the depressing output effect of a merger is strongest. In the extreme case of  $\rho = -1$  firm  $M$  produces the benchmark quantity  $q^*$  that maximizes expected cash flow, as the merger reduces the probability to distress to zero.

Policy implications of DC are very much different than those of LL in the previous chapter, where preferences of firm owners and consumers over the merger are aligned. DC imply this is not necessarily the case. There is a possible conflict between efficiency (diversification reduces cost of distress) and the expected surplus of consumers

(diversification reduces output). Firm owners might choose to merge their firms even though consumers suffer from a merger's negative quantity effect, and the net welfare effect may be positive or negative. Costs of distress are therefore an example where non-monotonic real effects of purely financial synergies can establish a rationale for policy intervention. A competition authority that aims to protect consumers should intervene whenever a merger motivated by positive financial synergies summons a negative quantity effect. Such a merger should be blocked, or permitted conditional on remedies that benefit consumers. More generally, the merger's impact on consumers depends on the stochastic interaction of firms' assets and cash flows, a property that is usually completely neglected by competition authorities.

## 5.4 Applications and Extensions

This section presents several applications and extensions of the above analysis. Unlike in the previous chapter, the common theme is not the explanation of stylized facts, but interesting implications of above results for different but closely related problems. The discussion covers implications for incremental mergers and myopic competition policy, asymmetric cross-border mergers, optimal horizontal boundaries, proportional costs of distress, and more general distress triggers.

### 5.4.1 Incremental Mergers and Myopic Competition Policy

Non-monotonic real effects of financial synergies pose a great challenge for efficient and effective competition policy. This application shows how a myopic competition authority (CA) blocks incremental mergers that are intermediate steps on the path to an efficient allocation of assets.<sup>4</sup>

Assume there are  $n$  symmetric uncorrelated product markets like in the merger model, and  $T$  consecutive periods, and ignore discounting and interaction between periods. Initially, there is a stand-alone firm in every market. In each period  $t \in \{1, \dots, T\}$  there is a single incremental merger that involves only two firms, starting with a diversifying merger of stand-alone firms in market 1 and 2 at the end of the first period. From this first merger emerges a diversified firm  $M$ .<sup>5</sup> At the beginning of the second period there is thus a conglomerate in markets  $\{1, 2\}$  and focused firms in the other markets. More generally, at the beginning of period  $t$  there is a conglomerate with business units in markets  $\{1, \dots, t\}$  and stand-alone firms in markets  $\{t + 1, \dots, n\}$ . At

<sup>4</sup>This extension is related to the literature on sequential mergers, for example, Fumagalli and Vasconcelos (2008).

<sup>5</sup>Restrictions about the number of firms involved in a merger and the number of mergers per period can be rationalized through the institutional complexity of the mergers process. For example, the CA could be constrained to handling a single case in each period, because of its limited resources.

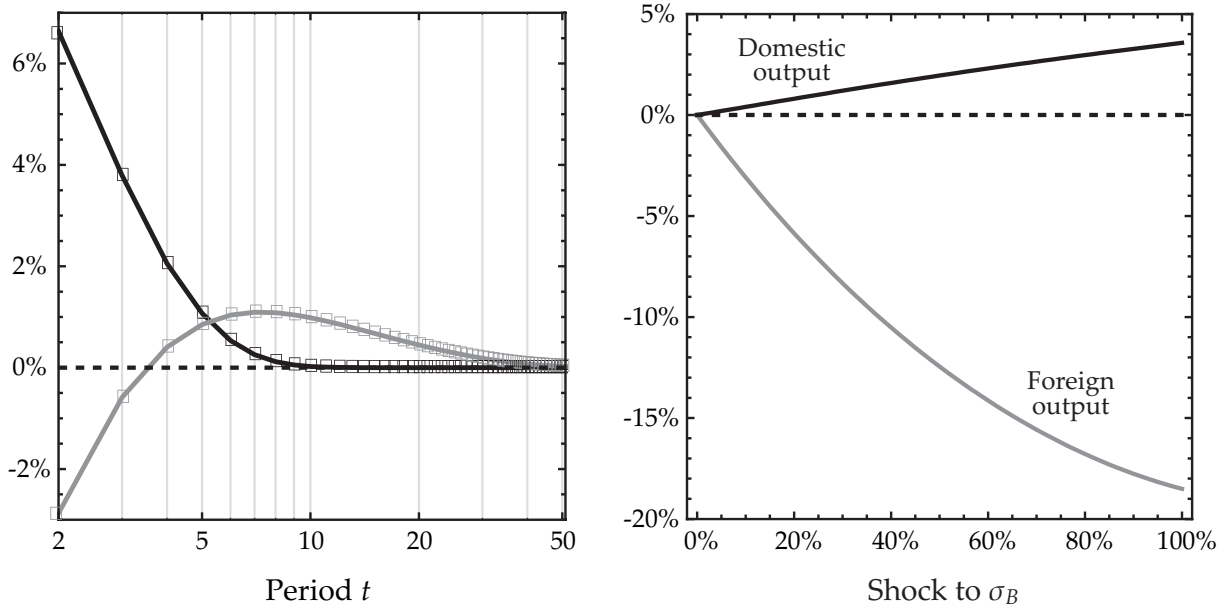


Figure 5.4: The left figure graphs the percentage change in firm  $M$ 's output  $q_M^*$  from period  $t - 1$  to period  $t$  that results from an incremental merger, where the black schedule refers once to low-risk markets ( $\sigma = 3$ ) and the gray schedule to high-risk markets ( $\sigma = 8$ ). The right figure graphs the percentage change in foreign and domestic output induced by an increase in foreign risk, as a function of the size of the shock in percent of initial risk  $\sigma_B = 6$ . As usual  $p(q) = 10 - q$ ,  $c = 2$  and  $\bar{D} = 25$ .

the end of period  $t$  the conglomerate merges with the stand-alone firm in market  $t + 1$ , so that the number of firms is reduced by one in each period. Importantly, each incremental merger requires permission from the CA. The permission is granted only if a merger has a strictly non-negative real quantity effect in the following period. In other words, whenever the merger at the end of period  $t$  depresses output in period  $t + 1$ , the merger is blocked. The CA is obviously myopic, as it is only concerned with a merger's immediate short-term implications for the next period.

The growth rate of the conglomerate's equilibrium output in period  $t$  is depicted in the left part of figure 5.4, given an example with  $n = 50$  markets and  $T = 50$  periods. Since DC cause a positive financial synergy, each incremental merger has a positive impact on total expected market values of firms, so there are incentives to merge in each period. In a low-risk environment output of the conglomerate strictly increases with every incremental merger, although the growth rate is decreasing. This is different in a high-risk environment, where the first two mergers have a negative impact on output, this follows from proposition 5.7. Output begins to rise with the third incremental merger, so that after the first seven mergers there is a net positive effect of diversification on output in a high-risk environment, that is, output in period  $t = 8$  is higher than in period  $t = 1$ . As time approaches the horizon  $T$ , output of the conglomerate approaches the benchmark quantity  $q^*$  in both high- and low-risk environments, and additional mergers have negligible effects on output. Efficiency requires that all

firms merge, as this minimizes expected DC and maximizes equilibrium output, so that maximum efficiency is attained with complete diversification.

Myopic competition policy has straightforward implications for such incremental mergers. Although the first few mergers are intermediate steps on a path to an efficient allocation of assets, they are blocked by authorities because of non-monotonic real effects. The path to a more efficient organization of firms' horizontal boundaries is thus closed. Although the aggregate effect of many incremental mergers yields a Pareto improvement, harmful transitory quantity effects of some intermediate incremental mergers induce intervention of a myopic competition authority. Only a far-sighted forward-looking CA recognizes the necessity of transitory negative quantity effects.

### 5.4.2 Asymmetric Mergers

Until now the analysis was constrained to mergers of symmetric firms. This extension discusses three interesting implications of asymmetries in the context of DC. First, with asymmetries financial synergies may be negative. Second, a merger of asymmetric firms induces redistribution of consumer surplus. Third, with distress cost asymmetric shocks are propagated across unrelated markets.

To examine consequences of asymmetries, consider two focused firms denoted by  $A$  and  $B$ . Firm  $A$  is located in a „domestic“ developed country, while firm  $B$  is based in a „foreign“ less developed country. Although both firms exhibit the same expected cash flow, firm  $B$ 's cash flow is significantly more risky than firm  $A$ 's, that is,  $\sigma_B > \sigma_A$ . Owners of firms  $A$  and  $B$  consider a merger. Expected market values of stand-alone firms are captured by (5.4) above. Unfortunately, as the two firms are not symmetric, the shortcut used to simplify the problem of the merged firm in the main analysis cannot be applied in this asymmetric setting. Explicitly, the expected market value of the merged firm is

$$V_M = E[\Pi_A] + E[\Pi_B] - \Pr\{\Pi_A + \Pi_B < 0\}(\bar{D}_A + \bar{D}_B), \quad (5.14)$$

where cash flow in country  $i = A, B$  is distributed with expected value  $E[\Pi_i] = \{p(q_i) - c_i\}q_i$  and variance  $\text{Var}[\Pi_i] = q_i^2\sigma_i^2$ . Associated first-order conditions are

$$\frac{\partial V_M}{\partial q_A} = \frac{\partial E[\Pi_A]}{\partial q_A} - \frac{\partial \Pr\{\Pi_A + \Pi_B < 0\}}{\partial q_A}(\bar{D}_A + \bar{D}_B) = 0 \quad (5.15)$$

$$\frac{\partial V_M}{\partial q_B} = \frac{\partial E[\Pi_B]}{\partial q_B} - \frac{\partial \Pr\{\Pi_A + \Pi_B < 0\}}{\partial q_B}(\bar{D}_A + \bar{D}_B) = 0 \quad (5.16)$$

The diversified firm equates each country's expected marginal cash flow with corresponding marginal DC. Since marginal DC in (5.15) and (5.16) depend on both quanti-

ties and standard deviations, output decisions are „linked”. Skipping a comprehensive analysis of the asymmetric problem, the three aforementioned implications of asymmetries are directly demonstrated using a special case of problem (5.17). As always, assume market  $i$  is characterized by expected demand  $p(q_i) = 10 - q_i$ , marginal cost  $c_i = 2$  and symmetric distress cost  $\bar{D}_i = 25$ . To capture the higher risk in the foreign market set  $\sigma_A = 3$  and  $\sigma_B = 6$ , with  $\rho_{AB} = 0$  in the base case. The equilibrium probability of distress risk of the stand-alone monopolist in the domestic country is relatively small at 6%, which suggests the domestic market is of a low-risk type according to definition 1 above. This is different in country  $B$ , where the stand-alone firm’s probability of distress is 29%, meaning the foreign country is a high-risk environment. As marginal DC in the foreign country are strictly higher because of the more volatile cash flow, output in the foreign country is lower than in the domestic country.

There are substantial incentives to merge foreign and domestic firms because of the positive financial synergy caused by DC: the expected market value of firm  $M$  is 9% higher than the combined value of focused firms. Yet financial synergies are not necessarily positive if merging firms are asymmetric, and this is the first important implication of asymmetries. For example, assume the coefficient of correlation between markets rises to  $\rho_{AB} = 0.7$ , for example, because of increasing economic integration. Financial synergies are now negative, as the merged firm faces higher expected DC than the two focused firms together. Generally, a merger of high and low-risk firms summons positive financial synergies only if the distress probability of the merged firm is less than the average distress probability of focused firms. This is not necessarily the case, since firm  $M$ ’s distress probability is a non-linear combination of focused firms’ probabilities.

But, even though synergies are positive in the base case, it is unclear whether foreign competition authorities would allow such a merger. If firms merge output in the foreign market  $B$  decreases by about 20% relative to the stand-alone case, while output in the domestic market increases by nearly 9%. Since expected surplus of foreign consumers decreases and surplus of domestic consumers increases, the merger implicitly allows domestic consumers to „steal” surplus from foreigners. A foreign competition authority would therefore most likely intervene and block the merger. The intuition for this result is essentially the same as in the symmetric case. The total effect of the merger is a reduction of uncertainty, which summons a positive financial synergy. Yet the diversified firm’s first-order conditions (5.15) and (5.16) are in disequilibrium at pre-merger output of focused firms. Marginal distress cost are higher (lower) than marginal cash flow in the foreign (domestic) country. To reach equilibrium, foreign output is reduced and domestic output expanded.

Furthermore, international diversification establishes links between countries that propagate asymmetric shocks from one economy to another. Bulow et al. (1985) argue



that market-specific shocks have repercussions for other product markets in settings where markets are served by a diversified firm with a cost structure that exhibits scope economies. Distress costs establish a shock propagation mechanism quite similar to scope economies. To see this, assume the standard deviation of the cash flow shock in the foreign country increases, for example, because of political turmoil or a natural disaster. The right part of figure 5.4 plots the percentage change in domestic and foreign equilibrium output of the merged firm as a function of the shock to  $\sigma_B$ , holding  $\sigma_A$  constant. Output in the foreign market decreases since the merged firm reduces its exposure to the increasing risk in the foreign market. This reduction of foreign output indirectly decreases marginal DC in the domestic market, which prompts higher domestic output. Hence DC establish a mechanism for the propagation of asymmetric shocks. Given recent increases in international diversification (Denis et al., 2002), countries should therefore become more prone to international propagation of shocks, and not more resilient, as claimed by the notorious „decoupling” hypothesis.

### 5.4.3 Optimal Horizontal Boundaries

Endogenous financial synergies caused by DC suggest there is an optimal configuration of firms’ horizontal boundaries, that is, an optimal allocation of asset ownership that maximizes some objective like the total expected market value of firms, total consumer surplus or total welfare. This optimal allocation is surprisingly sensitive to the stochastic interdependence of markets, an aspect usually neglected in the analysis of firm’s optimal horizontal boundaries in the context of operational synergies (eg Panzar and Willig, 1981). The following application shows how a seemingly innocuous change in this stochastic structure can have a significant impact on the optimal allocation of assets.

Generally, the design of optimal horizontal boundaries is a complex problem, since the number of possible allocations grows very quickly in the number of assets. In the simple case of only two assets there are only two possible allocations: two focused firms who each own a single asset, or a single diversified firm that owns both assets. More generally, given a set of  $n$  assets, the number of possible allocations — that is, the number of ways the set can be partitioned into non-empty subsets — is called the  $n$ th Bell number (for details, see Rota, 1964).<sup>6</sup> As the number of assets increases, the number of possible allocations (the Bell number) grows extremely quickly. For example, given a dozen assets there are already more than four million possible allocations, and given a comparatively small number of one hundred assets there are more allocations

<sup>6</sup>Alternatively, bell numbers can be viewed as the number of distinct possible ways of putting  $n$  distinguishable balls (assets in the present context) into  $1 \leq m \leq n$  indistinguishable boxes (product portfolios, or horizontal boundaries of firms). The first few Bell numbers for  $n = 1, 2, 3, \dots$  are 1, 2, 5, 15, 52, 203, 877, 4140, 21147, 115975.

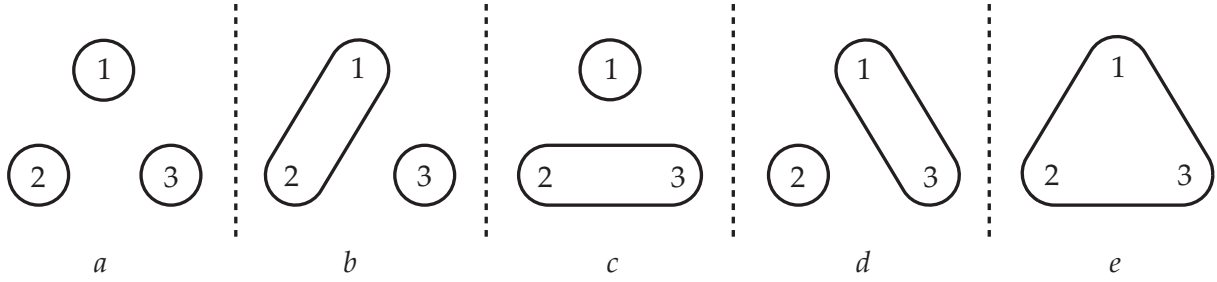


Figure 5.5: Five possible allocations of  $n = 3$  assets, ranked from left to right according to increasing diversification of firms. Numbers indicate assets (monopolies in the present context). Numbers enclosed by a common line belong to the same firm.

than positions in a chess play ( $\approx 10^{43}$ ) or estimated atoms in the universe ( $\approx 10^{120}$ ).

Yet the fragility of optimal horizontal boundaries can be demonstrated in comparatively simple cases with just a few asymmetric assets. For example, assume there are three unrelated quantity-setting monopolies (assets) indexed by  $i \in \{1, 2, 3\}$ . Monopolies differ only in the riskiness of cash flows, so assume  $\sigma_1 < \sigma_2 < \sigma_3$ . There are five possible allocations of assets to horizontal boundaries of firms, depicted in figure 5.5. The expected market value of a firm that owns a subset of assets  $\mathbb{M} \subseteq \{1, 2, 3\}$  is

$$V_M = \sum_{i \in \mathbb{M}} E[\Pi_i] - \Pr \left\{ \sum_{i \in \mathbb{M}} \Pi_i < 0 \right\} \sum_{i \in \mathbb{M}} \bar{D}_i. \quad (5.17)$$

To compute expected total consumer surplus, expected total market values of firms and expected total welfare associated with each allocation in figure 5.5, assume monopolies 1 and 2 exhibit low-risk cash flows that are highly correlated, for example, if monopolies 1 and 2 are based in neighboring countries with strong trade ties. Assume further cash flow of monopoly 3 is comparatively risky and not correlated with other cash flows, for example, because the third asset is based in a distant emerging economy.<sup>7</sup> Examples of equilibrium values associated with each allocation are listed in table 5.1, for parameter specifications as summarized in the caption. The base case is characterized by the already thoroughly discussed conflict between consumers and firm owners. Surplus of consumers is maximized at allocation  $b$ , where a conglomerate owns monopolies 1 and 2, while the high-risk monopoly is owned by a stand-alone firm. Market values and overall welfare are maximized at allocation  $e$ , where all assets belong to a single diversified firm. These optimal horizontal boundaries are not

<sup>7</sup>The stochastic structure of markets is summarized by the variance-covariance matrix of cash flow shocks

$$\Sigma = \begin{pmatrix} \sigma_1^2 & \rho_{12}\sigma_1\sigma_2 & \rho_{13}\sigma_1\sigma_3 \\ \rho_{12}\sigma_1\sigma_2 & \sigma_2^2 & \rho_{23}\sigma_2\sigma_3 \\ \rho_{13}\sigma_1\sigma_3 & \rho_{23}\sigma_2\sigma_3 & \sigma_3^2 \end{pmatrix}. \quad (5.18)$$

Given the parametrization in the caption of table (5.1), matrix (5.18) is positive-definite and therefore a proper variance-covariance matrix.

	Base case		Variation 1			Variation 2			
	Consumer surplus	Market values	Total welfare	Consumer surplus	Market values	Total welfare	Consumer surplus	Market values	Total welfare
<i>a</i>	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	<b>100,0%</b>	100,0%	100,0%
<i>b</i>	<b>100,6%</b>	102,4%	101,8%	100,6%	102,4%	101,8%	94,6%	98,8%	97,3%
<i>c</i>	96,7%	108,5%	104,6%	97,2%	111,8%	107,0%	96,2%	111,9%	106,2%
<i>d</i>	94,5%	106,4%	102,4%	95,4%	109,2%	104,6%	94,6%	107,2%	102,6%
<i>e</i>	98,6%	<b>115,4%</b>	<b>109,8%</b>	<b>102,3%</b>	<b>120,6%</b>	<b>114,4%</b>	92,8%	<b>116,3%</b>	<b>107,7%</b>

Table 5.1: Expected total consumer surplus, expected total market values and expected total welfare in the five different configurations of horizontal boundaries depicted in figure (5.5). As usual,  $p(q_i) = 10 - q_i$ ,  $c_i = 2$ ,  $\bar{D}_i = 25$ . The base case is  $\sigma_1 = 3$ ,  $\sigma_2 = 4$  and  $\sigma_3 = 8$ , and  $\rho_{12} = 0.7$  and  $\rho_{13} = \rho_{23} = 0$ . Variation 1 is  $\rho_{13} = \rho_{23} = -0.2$ , and variation 2 is  $\sigma_2 = 8$ . In each column values of the fully specialized allocation (*a*) are set equal to 100%. For example, the entry in the last row of the last column means that total welfare in allocation (*e*) is 7.7% percentage higher than in allocation (*a*), given that  $\sigma_2 = 8$ .

robust to small changes in the variance-covariance matrix of shocks. For example, assume the high-risk monopoly „decouples“, that is, becomes negatively correlated with other assets, which is the first variation of the base case in table 5.1. A relatively small change in the covariance structure completely resolves the conflict between firm owners and consumers, as both groups now are best off at allocation *e*. Alternatively assume there is a „disruptive“ technology shock that doubles the variability of cash flow of monopoly 2, the second variation of the base case. Such a shock amplifies the conflict between consumers and owners, as consumers now suffer from any merger. This simple example shows that optimal horizontal boundaries can be very sensitive to seemingly insignificant changes in the stochastic interdependence of assets. Finally, table (5.1) offers another interesting insight. Notice that allocation *d* follows from allocation *b* if asset 1 is sold from firm „12“ to firm „3“, so that there are firms „2“ and „13“ after the transaction. Such a transaction involves no change in overall concentration or „average diversification“ of firms. Yet consumers suffer substantially from real effects of such a transaction.

#### 5.4.4 Proportional Distress Costs

The following two variations examine the robustness of results with respect to assumptions about the nature of DC. Costs of distress as specified by (5.1) are fixed in the sense that the value of DC is either zero or  $m\bar{D}$ , but never proportional to the ex post value of assets. An alternative specification very popular in the corporate finance literature assumes DC are proportional to the value of assets. A switch from fixed to proportional DC significantly alters results of the analysis. Assume ex post DC are now proportional

to the value of total cash flow and given by

$$d = \begin{cases} 0 & \text{if } y \geq 0 \\ -\beta y & \text{if } y < 0 \end{cases},$$

where  $\beta > 0$  captures the amount of DC in percentage terms of total cash flow  $y$ . For example, if  $\beta = 0.2$  and ex post cash flow  $y = -\$100$ , then DC are  $D = \$20$ , or 20% of cash flow, and the firm's market value is  $v = -\$120$ . Financial synergies and associated quantity effects hinge on the basic relation between the standard deviation of the cash flow shock and expected total and marginal cost of distress. If expected DC decline as the standard deviation decreases, then a merger summons a positive financial synergy. If expected marginal DC rise (decline) as the standard deviation increases, then equilibrium quantities decline (rise) after the merger. With fixed DC the preferences of firm owners and consumers over the merger were possibly unaligned, as expected DC can decrease (implying positive financial synergies) while marginal DC increase (a negative quantity effect). This is different with proportional DC. Straightforward differentiation of a focused firm's expected proportional DC yields

$$\frac{\partial E[D_S]}{\partial \sigma} = \beta f(\hat{z}) q \sigma > 0,$$

while the impact of more uncertainty on marginal distress cost is

$$\frac{\partial^2 E[D_S]}{\partial q \partial \sigma} = \frac{\beta f(\hat{z}) [\sigma^2 + \hat{z} p'(q) q]}{\sigma} > 0,$$

since both  $p'(q) < 0$  and  $\hat{z} < 0$ .<sup>8</sup> Thus, if DC are proportional both expected and marginal cost of distress strictly increase in the standard deviation of the cash flow shock. There is a monotonic inverse relation between equilibrium output of firms and the standard deviation of shocks: firm  $M$  exhibits strictly lower marginal DC and therefore produces strictly more output than focused firms, so that  $q^* > q_M^* > q_S^*$  with proportional DC. Preferences of firm owners and consumers over a conglomerate merger are therefore always aligned: producers benefit directly from financial synergies, while consumers benefit indirectly from higher equilibrium output. This is the reverse of results that emerged from the analysis of limited liability.

<sup>8</sup>Explicitly, expected proportional DC of a focused firm are given by

$$D_S = \begin{cases} 0 & \text{if } \pi(q, Z) \geq 0 \\ -\beta \pi(q, Z) & \text{if } \pi(q, Z) < 0 \end{cases}.$$

### 5.4.5 General Distress Triggers

Up to this point the critical threshold that triggers distress was assumed to be strictly zero. But, more generally, any ex post value of cash flow can be rationalized as a trigger of some kind of DC. So assume now distress is triggered whenever cash flow falls below some arbitrary exogenous value  $\Gamma \in \mathbb{R}$ . This assumption is captured by

$$d = \begin{cases} 0 & \text{if } y \geq m\Gamma \\ m\bar{D} & \text{if } y < m\Gamma \end{cases}, \quad (5.19)$$

where  $m$  denotes the number of a firm's business units and  $y$  total cash flow, so that DC are still invariant to the scale of firms. Consequences of this variation again depend on implications for relations between expected total and marginal DC and the extent of uncertainty. Consider once again a representative stand-alone firm  $S$ , and let  $\hat{z}$  be critical realization of the cash flow shock at which the firm's cash flow just equals the critical threshold  $\Gamma$ , that is, the solution to the implicit equation  $\pi(q, \hat{z}) = \Gamma$ . The expected value of the representative firm's cost of distress is thus  $E[D_S] = F(\hat{z})\bar{D}$ . The main implication of general triggers is that distress probabilities are no longer constrained to less than 0.5, and the value expected financial synergies may now be negative. Explicitly, if the representative firm's equilibrium probability of distress is smaller (greater) than  $F(0) = 0.5$ , then the firm's expected DC locally increase (decrease) as the standard deviation of the cash flow shock increases, since

$$\frac{\partial E[D_S]}{\partial \sigma} = \frac{\hat{z}}{\sigma} f(\hat{z}) \bar{D}$$

has the same sign as  $\hat{z}$ , that is,  $\hat{z} < 0$  implies  $F(\hat{z}) < 0.5$  and  $\hat{z} > 0$  implies  $F(\hat{z}) > 0.5$ . Hence financial synergies are negative if distress probabilities exceed 0.5. Real quantity effects of synergies are still non-monotonic with more general distress thresholds, so that consumers may both benefit and suffer if firms merge.

## 5.5 Summary

This chapter examined real effects of purely financial synergies caused by cost of distress. The main result is that corporate diversification is not always an efficiency enhancing free lunch. Whereas firm owners generally benefit from the risk reduction associated with diversification and thus merge their firms to reduce the expected value of DC, consequences for consumers are ambiguous. Especially in very risky market environments, where incentives to merge are greatest, firms tend to produce less output with diversification. The explanation for unaligned preferences of firm owners and consumers is that incentives to merge depend on the cumulative probability of

distress, whereas real effects depend on the marginal probability of distress. The cumulative probability strictly decreases in the extent of diversification, but the marginal probability of distress reacts in a non-monotonic way. A merger may thus harm consumers. Contrary to limited liability, financial synergies caused by DC can therefore establish a case for competition policy.

Several applications and extensions examined implications of non-monotonic real effects. Myopic competition policy might block mergers that are intermediate steps towards a more efficient allocation of assets. The example of a cross-border merger showed how a merger of asymmetric firms induces redistribution of consumer surplus between markets. Optimal horizontal boundaries of firms were shown to be very sensitive to the variance-covariance structure of markets, a notion usually neglected in the examination of optimal horizontal boundaries. These results depend on assumptions about the nature of DC, for example, whether they are fixed vs. proportional.

## 5.6 Proofs

### Proposition 5.1

*Proof.* Implicit differentiation of first-order condition (5.6) yields

$$\frac{dq_S^*}{d\bar{D}} = \frac{\left(\frac{\partial \hat{z}}{\partial q}\right) f(\hat{z})}{V_S''}.$$

From the definition of  $\hat{z}$  fol  $(\partial \hat{z} / \partial q) \equiv -(\partial p(q) / \partial q) > 0$ , while  $f(\hat{z})$  is strictly positive and  $V_S''$  negative because  $V_S$  is globally concave, so  $(dq_S^* / d\bar{D}) < 0$ . If  $\bar{D} = 0$  the second term on the right hand side of (5.6) vanishes, so  $q_S^* = q^*$ . Hence, if  $\bar{D} = 0$  then  $q_S^* = q^*$ , and if  $\bar{D} > 0$  then  $q_S^* < q^*$ .  $\square$

### Proposition 5.2

*Proof.* The derivative of  $V_S^*$  with respect to  $\sigma$  is

$$\frac{dV_S^*}{d\sigma} = \frac{\partial V_S}{\partial \sigma} + \left(\frac{\partial q_S^*}{\partial \sigma}\right) V_S'.$$

The second term is zero since the first-order condition  $V_S' = 0$  is satisfied at  $q_S^*$  (the envelope theorem). The sign of  $(dV_S^* / d\sigma)$  is thus determined by the first term, which is

$$\frac{\partial V_S}{\partial \sigma} = \frac{\hat{z}}{\sigma} f(\hat{z}) \bar{D} < 0$$

and clearly negative, since  $\hat{z} < 0$ . Hence  $(dV_S^* / d\sigma) < 0$  in equilibrium.  $\square$

### Proposition 5.3

*Proof.* Implicit differentiation of the firm's first-order condition shows

$$\frac{dq_S^*}{d\sigma} = - \frac{\left(\frac{\partial f(\hat{z})}{\partial \sigma}\right) \left(\frac{\partial \hat{z}}{\partial q}\right) \bar{D}}{V_S''}.$$

Since  $(\partial \hat{z} / \partial q) > 0$  and  $V_S'' < 0$ , the sign of  $(dq_S^* / d\sigma)$  is determined by the sign of  $(\partial f(\hat{z}) / \partial \sigma)$ . The closed form of the normal distribution's probability density function reveals

$$\text{sign} \left( \frac{\partial f(\hat{z})}{\partial \sigma} \right) = \text{sign} (\sigma + \hat{z}).$$

Thus three cases are possible. Firstly, if  $\sigma < |\hat{z}|$  in equilibrium (which is equivalent to  $F(\hat{z}) < F(-\sigma)$ , the case of a low-risk environment), then locally  $(\partial f(\hat{z}) / \partial \sigma) < 0$  and consequently  $(dq_S^* / d\sigma) < 0$ . Secondly, if  $\sigma > |\hat{z}|$  in equilibrium (which is equivalent to  $F(\hat{z}) > F(-\sigma)$ , the case of a high-risk environment), then locally  $(\partial f(\hat{z}) / \partial \sigma) > 0$  and consequently  $(dq_S^* / d\sigma) > 0$ . Thirdly, if  $\sigma = |\hat{z}|$  in equilibrium, then locally  $(dq_S^* / d\sigma) = 0$  since  $(\partial f(\hat{z}) / \partial \sigma) = 0$ . Thus output is a U-shaped function of  $\sigma$  with a single turning point at  $\sigma = |\hat{z}|$ . For very low and very large values of  $\sigma$  the value of  $f(\hat{z})$  becomes very small, so the second term on the right hand side of (5.6) approaches zero, and  $q_S^*$  approaches  $q^*$ .  $\square$

### Proposition 5.4

*Proof.* It follows from  $\bar{\rho} = 1$  that  $\sigma = \bar{\sigma}$ . Now, if  $q_S = q_M = q$  then  $\hat{z} = \hat{z}$  and  $nV_S(q) = V_M(q)$  for all  $q$ . Since at  $\bar{\rho} = 1$  total expected market values with and without a merger are equivalent, first-order conditions are solved by the same equilibrium quantities, that is, if  $\bar{\rho} = 1$  then  $q_S^* = q_M^*$ .  $\square$

### Proposition 5.5

*Proof.* The effect of a marginal increase in  $\bar{\rho}$  on  $V_M^*$  is

$$\frac{\partial V_M^*}{\partial \bar{\rho}} = \left(\frac{\partial \bar{\sigma}}{\partial \bar{\rho}}\right) \left(\frac{\partial V_M}{\partial \bar{\sigma}}\right) + \left(\frac{\partial \bar{\sigma}}{\partial \bar{\rho}}\right) \left(\frac{\partial q_M^*}{\partial \bar{\sigma}}\right) V_M'.$$

The envelope theorem suggests the second term is zero, as the first-order condition  $V_M' = 0$  is satisfied at  $q_M^*$ . The standard deviation of the average shock is strictly increasing in the correlation coefficient, that is,  $(\partial \bar{\sigma} / \partial \bar{\rho}) > 0$ . The sign of  $(\partial V_M^* / \partial \bar{\rho})$  therefore depends on the direct effect of increases in  $\bar{\sigma}$  on  $V_M$ . It follows from 5.2 that  $(\partial V_M / \partial \bar{\sigma}) < 0$  and thus  $(\partial V_M^* / \partial \bar{\rho}) < 0$ . Starting at  $\bar{\rho} = 1$ , where  $\Delta V = 0$ , a decrease

in  $\bar{\rho}$  strictly decreases  $\bar{\sigma}$  and expected distress cost. Hence if  $\bar{\rho} < 1$  then  $\Delta V > 0$  in equilibrium.  $\square$

### Proposition 5.6

*Proof.* The proposition is true in case  $(\partial q_M^*/\partial \bar{\rho}) < 0$  in a low-risk environment. Implicit differentiation of the diversified firm's first-order condition (5.13) reveals

$$\frac{dq_M^*}{d\bar{\rho}} = -\frac{\left(\frac{\partial \bar{\sigma}}{\partial \bar{\rho}}\right) \left(\frac{\partial g(\hat{z})}{\partial \bar{\sigma}}\right) \left(\frac{\partial \hat{z}}{\partial q}\right) g(\hat{z}) n \bar{D}}{V_M''}.$$

Since  $(\partial \bar{\sigma}/\partial \bar{\rho}) > 0$  and  $(\partial \hat{z}/\partial q) < 0$  the sign of this expression depends on the sign of  $(\partial g(\hat{z})/\partial \bar{\sigma})$ , which is equivalent to the sign of  $(\bar{\sigma} + \hat{z})$ . Hence the proposition is true if  $\bar{\sigma} < |\hat{z}|$  in an equilibrium without a merger, which is by definition the case in a low-risk environment, where  $F(\hat{z}) < F(-\sigma)$  and hence  $\sigma < |\hat{z}|$  in equilibrium. For  $\bar{\rho} = 1$  it follows that  $\bar{\sigma} = \sigma < |\hat{z}| = |\hat{z}|$  and thus  $(\partial q_M^*/\partial \bar{\rho}) < 0$ , and the representative market of the conglomerate is a low-risk environment. Starting at  $\bar{\rho} = 1$ , a reduction in  $\bar{\rho}$  then strictly reduces  $q_M^*$  and  $|\hat{z}|$ , so the sign of  $\sigma < |\hat{z}|$  is always preserved. Hence from  $\bar{\rho} < 1$  and  $F(\hat{z}) < F(-\sigma)$  without a merger imply  $(\partial q_M^*/\partial \bar{\rho}) < 0$ .  $\square$

### Proposition 5.7

*Proof.* In high-risk product markets  $F(\hat{z}) > F(-\sigma)$  and thus  $\sigma > |\hat{z}|$  without a merger, and it follows from proposition 5.4 that firm  $M$ 's average product market is as well of a high-risk type in case  $\bar{\rho} = 1$ , since then  $\bar{\sigma} = \sigma > |\hat{z}| = |\hat{z}|$  and thus  $G(\hat{z}) > G(-\bar{\sigma})$ , so that  $(\partial q_M^*/\partial \bar{\rho}) > 0$  at  $\bar{\rho} = 1$ . Starting at  $\bar{\rho} = 1$ , a reduction in  $\bar{\rho}$  strictly decreases  $q_M^*$  and  $\bar{\sigma}$  but increases  $|\hat{z}|$  until the sign of  $\bar{\sigma} > |\hat{z}|$  is reversed, so eventually  $\bar{\sigma} < |\hat{z}|$  and thus  $(\partial q_M^*/\partial \bar{\rho}) < 0$ . In other words, in a high-risk environment output of firm  $M$  is a U-shaped function of the average correlation coefficient. Hence there exists some critical  $\hat{\rho}$  at which  $q_M^* = q_S^* < q^*$ . If  $\bar{\rho} > \hat{\rho}$  a merger reduces output and if  $\bar{\rho} < \hat{\rho}$  the merger increases output.  $\square$



# Chapter 6

## Asymmetric Corporate Taxation

*The art of taxation consists in so plucking the goose as to obtain the largest amount of feathers with the least amount of hissing.*

— Jean Colbert

### 6.1 Introduction

Several properties of tax tariffs can cause financial synergies.<sup>1</sup> This chapter examines the most notorious of such features: asymmetric taxation of a firm's profits and losses, or, put differently, the unwillingness of government to share equally in firms' gains and losses for tax purposes (Heaton, 1987).

Altshuler and Auerbach (1990) and Eldor and Zilcha (2002) examine worldwide corporate tax codes and identify a ubiquitous asymmetry between the taxation of profits and the compensation for losses. Whereas the tax rate on positive income is on average about 30% (see table 6.1), the „compensation rate“ on negative income is usually zero. In theory asymmetric taxation of positive and negative income within a single period is mitigated in a multi-period context because of loss „carryforwards“ and „carrybacks“ that allow „tax-offsetting“ to improve the compensation for losses. Yet there are at least five reasons why this mitigation through intertemporal tax-offsetting is highly incomplete empirically. First, as is clearly visible in table (6.1), loss carrybacks are not allowed in most countries. So firms that suffer a loss in any given year cannot claim a reimbursement on taxes paid in earlier years. Second, the table reveals as well that the number of periods that losses can be carried backward is usually limited to at most 3 years in countries like the US or UK that allow loss carrybacks. Third, more generally, loss carrybacks are irrelevant to young firms. Fourth, loss carryforwards imply opportunity cost because future compensation is uncertain and delayed. Fifth, the volume of losses that can be carried forward to future periods is often limited, for ex-

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<sup>1</sup>See Auerbach and Reishus (1988) for a survey on tax-related motives for mergers and acquisitions.

Country	Corporate tax rate	Tax offsetting	
		Loss carryforward	Loss carryback
Australia	30%	7 years	None
Austria	25% (+minimum)	Unlimited	None
Belgium	34%	Unlimited	None
Brazil	15% (+surcharge)	Unlimited	None
Denmark	25%	Unlimited	None
Finland	26%	Unlimited	None
France	34%	5 years	3 years
Germany	Progressive, 30%	Unlimited	1 year
India	40%	8 years	None
Israel	36%	Unlimited	None
Japan	40%	5 years	1 year
Korea	27%	5 years	None
Luxembourg	30%	Unlimited	None
Mexico	28%	10 years	None
Netherlands	25%	Unlimited	3 years
Norway	28%	10 years	2 years
United Kingdom	Progressive, 28%	Unlimited	3 years
United States	Progressive, 39%	20 years	3 years

Table 6.1: Tax rates and provisions on loss carryforwards and carrybacks in selected countries, compiled from Eldor and Zilcha (2002), Ramb (2007) and the OECD tax database (<http://www.oecd.org/ctp/taxdatabase>). Corporate tax rates refer to combined central and sub-central (regional) tax rates. Where a progressive (as opposed to flat) rate structure applies, the top marginal rate is shown.

ample, in Germany losses may offset at most 60% of profits in any single future period (Ramb, 2007). In other words, it is well recognized that the tax treatment of corporate profits and losses is not symmetric in the sense that profits usually attract immediate payments to tax authorities, whereas losses do not attract immediate compensation payments (Appelbaum and Katz, 1987). Estimates suggest that such limitations on tax offsetting imply that the effective compensation rate on losses is only half the tax rate on profits (Auerbach and Reishus, 1988). Hence, if profits are taxed at 30%, then the effective compensation rate for losses is only 15%.

Asymmetric taxation of profits and losses is often argued to establish incentives for mergers and acquisitions (eg Auerbach and Reishus, 1988; Copeland et al., 2005). For example, a firm that has accrued a loss can acquire a profitable firm to consolidate its loss and the acquired firm's profit. If compensation for present losses in future periods is limited because of asymmetric taxation, the immediate consolidation of losses and profits in the present period allows both firms to reduce their total expected tax payment, so there is a positive financial synergy because of asymmetric taxation. Since consolidation of profits and losses of the same business across different periods is lim-

ited, unlimited consolidation of profits and losses of different businesses within the same period is profitable.

To examine these financial synergies and associated real effects caused by asymmetric taxation, assume in this chapter cash flows are taxed according to a proportional tariff with constant but different marginal tax rates on profits and losses. More precisely, if  $y \in \mathbb{R}$  denotes a firm's total cash flow, assume the ex post tax payment  $t$  of the firm to the tax authority is

$$t = \begin{cases} \tau_p y & \text{if } y \geq 0 \\ \tau_l y & \text{if } y < 0 \end{cases} \quad (6.1)$$

where  $0 < \tau_p, \tau_l < 1$  are constant marginal tax rates on profits and losses respectively. A negative total cash flow means that a firm receives a subsidy from the tax authority (a negative tax payment), whereas a positive cash flow means the tax authority receives a payment from the firm (positive tax payment). The expected tax payment  $T$  is given by the expected value of (6.1), which in turn determines the effective average tax rate  $\bar{\tau} = T/Y$ , where  $Y$  is expected cash flow. Symmetry or asymmetry of a tariff  $(\tau_l, \tau_p)$  is captured by the tax rate differential

$$\Delta\tau = \tau_p - \tau_l. \quad (6.2)$$

A zero tax rate differential means a tariff is symmetric, and profits and losses are treated equally, while a non-zero differential is a feature of asymmetric tariffs. The above discussed under-compensation for losses in reality corresponds to a positive differential, while a negative differential implies over-compensation. The empirical value of the differential is about  $\tilde{\Delta}\tau \approx 0.15$ , since the average marginal tax rate on profits is 30% (see table 6.1), while the average compensation rate has been estimated as half as high as the rate on profits (Auerbach and Reishus, 1988).

Tariff (6.1) has straight-forward implication for the valuation function  $v(\cdot)$ . Explicitly, if  $v(y)$  is the after-tax market value of a firm as a function of the pre-tax cash flow  $y$ , and given that firms exhibit unlimited liability and face no costs of distress, then (6.1) implies

$$v = \begin{cases} (1 - \tau_p)y & \text{if } y \geq 0 \\ (1 - \tau_l)y & \text{if } y < 0 \end{cases}. \quad (6.3)$$

This specification is clearly non-decreasing and invariant to scale, as multiplication of any given cash flow with a positive factor scales the market value by the same factor, so scale has a strictly proportional impact on market values. A positive expected value of taxes represents a financial wedge between asset and market values, as firm owners and the tax authority in effect „share“ a firm's cash flow. Examples of valuation func-

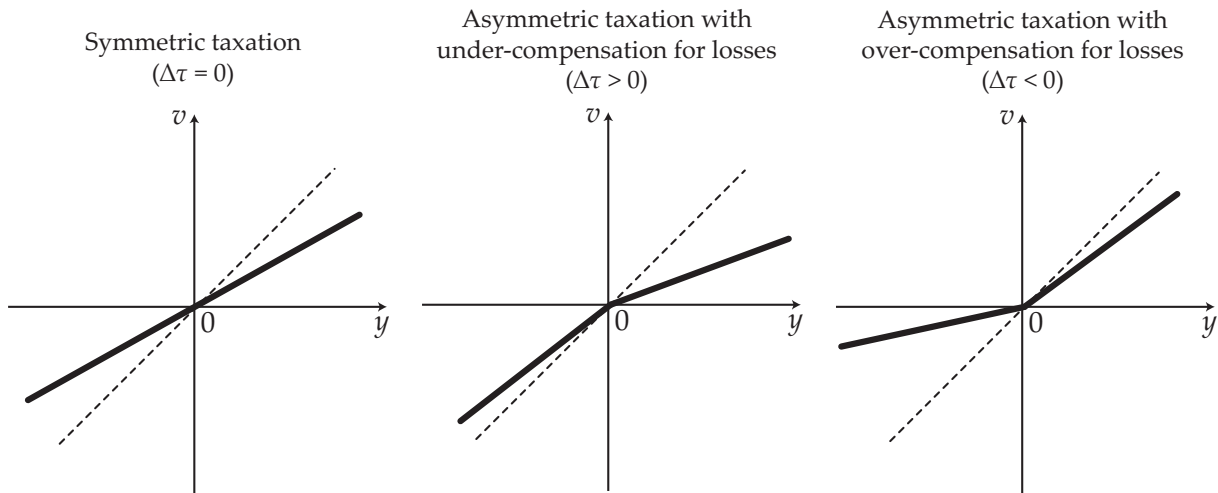


Figure 6.1: The relation between the ex post value of a firm's assets  $y$  (its cash flow) and its ex post market value  $v$  with symmetric corporate taxation (left), asymmetric corporate taxation that discriminates against losses (center) or profits (right). The dashed line is given by  $v = y$ .

tions with symmetric and asymmetric taxation are depicted in figure (6.1). Notice that a positive tax rate differential implies a concave valuation function, while a negative differential implies a convex function.

This chapter examines implications of the valuation function (6.3) for firm behavior and financial synergies. As in previous chapters, the analysis starts in section (6.2) with the basic output distortion associated with tariff (6.1), section (6.3) then examine financial synergies and associated real effects. Section (6.4) discusses a few applications and extensions, and section (6.5) summarizes findings.

The policy analysis differs from the previous two chapters, since there are now three policy instruments and two different policy authorities with different objectives. The competition authority aims to maximize the surplus of consumers and can either block a merger or let it go through. The tax authority in turn is only concerned with tax revenue and chooses a tax tariff that yields some exogenously given expected amount of taxes. The central policy issue in this chapter is therefore not only a possible conflict of interest between firm owners and consumers, but a possible conflict between tax and competition authorities as well.

## 6.2 Output Distortions

Non-linear tax tariffs often have distortionary effects on firm behavior. This section examines the basic output distortion of a tariff  $(\tau_p, \tau_l)$  on equilibrium output of a representative focused stand-alone firm  $S$  in market  $i$  that maximizes the after-tax value  $V_S$  of its cash flow. Again index  $i$  is suppressed in the following. Like in previous chapters, the problem of firm  $S$  is best formulated in terms of a critical realization  $\hat{z}$

(see previous chapters for a detailed explanation of this approach). The problem is

$$\max_q! \quad V_S = (1 - \tau_l) \int_{-\infty}^{\hat{z}} \pi(q, z) dF(z) + (1 - \tau_p) \int_{\hat{z}}^{\infty} \pi(q, z) dF(z), \quad (6.4)$$

where  $\hat{z} = c - p(q)$  is the realization of the cash flow shock at which cash flow is exactly zero. In all states of the world  $z < \hat{z}$  negative cash flow (loss) is compensated at marginal tax rate  $\tau_l$ , while in states of the world  $z > \hat{z}$  where cash flow is positive (profit) the marginal tax rate  $\tau_p$  applies. The first order condition of problem (6.4) is

$$V'_S = (1 - \tau_l) \int_{-\infty}^{\hat{z}} \frac{\partial \pi(q, z)}{\partial q} dF(z) + (1 - \tau_p) \int_{\hat{z}}^{\infty} \frac{\partial \pi(q, z)}{\partial q} dF(z) = 0, \quad (6.5)$$

and the second order condition  $V''_S < 0$  is always satisfied since problem (6.4) is by assumption globally concave in output.<sup>2</sup> Let  $q_S^*$  be the equilibrium quantity that solves (6.5) and  $V_S^* = V_S(q_S^*)$  the corresponding equilibrium market value of firm  $S$ , and recall  $q^*$  is benchmark output that maximizes the expected value of (pre-tax) cash flow. The impact of any given tariff  $(\tau_l, \tau_p)$  on equilibrium output of firm  $S$  is summarized by the following proposition. Again, all proofs can be found at the end of this chapter in section (6.6).

**Proposition 6.1.** *With symmetric corporate taxation the representative firm produces the benchmark quantity  $q^*$ . Under-compensation (over-compensation) for losses implies the firm produces less (more) than  $q^*$ . Hence*

$$\begin{aligned} \Delta\tau = 0 &\implies q^* = q_S^*, \\ \Delta\tau > 0 &\implies q^* > q_S^*, \\ \Delta\tau < 0 &\implies q^* < q_S^*. \end{aligned}$$

Symmetric taxation of profits and losses has no distortionary impact on output. But the empirically observed under-compensation for losses means that risk-neutral firms put extra emphasis on bad states of the world, where under-compensation by tax authorities means that losses „hurt even more“. Emphasis on states with low demand and high cost requires less output relative to symmetric taxation. Such a reduction of output decreases the expected tax payment more than the firm's expected cash flow, so that its expected after-tax value is higher because of lower output. These results complement earlier findings by Appelbaum and Katz (1987) who examine asymmetric taxation in a context with perfect competition, and results by Eldor and Zilcha (2002) about distortions associated with under-compensation. Consumers dislike the distortionary effect of under-compensation for losses, as output decreases and the expected

<sup>2</sup>There are other terms in the first order condition that result from the change in  $\hat{z}$ . Yet these terms are zero from the definition of  $\hat{z}$ .

price increases. The alternative case of over-compensation induces higher output than symmetric or no taxation, as the impact of too much output relative to  $q^*$  is cushioned by relatively over-compensation for losses. Consumers benefit from such a distortion, as equilibrium output increases.

Hence asymmetric taxation allows tax authorities subtle manipulation of firm output, as will be discussed below. But notice first the following proposition that summarizes the comparative statics of firm behavior.

**Proposition 6.2.** *Comparative statics of equilibrium market values and quantities depend on the tax rate differential. Under-compensation (over-compensation) for losses implies the representative firm's expected market value and output are strictly decreasing (increasing) in the standard deviation of the cash flow shock. Symmetric taxation implies uncertainty has no impact on firm behavior. Hence*

$$\begin{aligned}\Delta\tau = 0 &\implies \frac{dV_S^*}{d\sigma}, \frac{dq_S^*}{d\sigma} = 0, \\ \Delta\tau > 0 &\implies \frac{dV_S^*}{d\sigma}, \frac{dq_S^*}{d\sigma} < 0, \\ \Delta\tau < 0 &\implies \frac{dV_S^*}{d\sigma}, \frac{dq_S^*}{d\sigma} > 0.\end{aligned}$$

Furthermore, equilibrium output is globally increasing (decreasing) in the marginal tax rate on losses (profits), that is,

$$\begin{aligned}\frac{dq_S^*}{\tau_p} &< 0, \\ \frac{dq_S^*}{d\tau_l} &> 0.\end{aligned}$$

Under-compensation for losses establishes comparative statics that resemble risk-aversion (Sandmo, 1971; Leland, 1972): with uncertainty firms produce less output than with certainty, and output is decreasing in the degree and extent of uncertainty. Alternatively, over-compensation for losses corresponds to risk-affinity, where more risk means higher expected market values and more output. Output of firms is generally sensitive to the tax code, and changes in tax legislation imply real distortions. The higher the absolute value of the tax rate differential, the higher the absolute value of the output distortion, so more asymmetric tax codes are associated with stronger output distortions. Furthermore, tax authorities have two instruments to manipulate firm output. To increase output they may either decrease the marginal tax rate on profits or increase the marginal tax rate on losses. The recent loosening of limitations on tax offsetting in Germany, documented by Ramb (2007), should have stimulated output of firms with market power.

The analysis has interesting implications for sophisticated tax policy. For example,

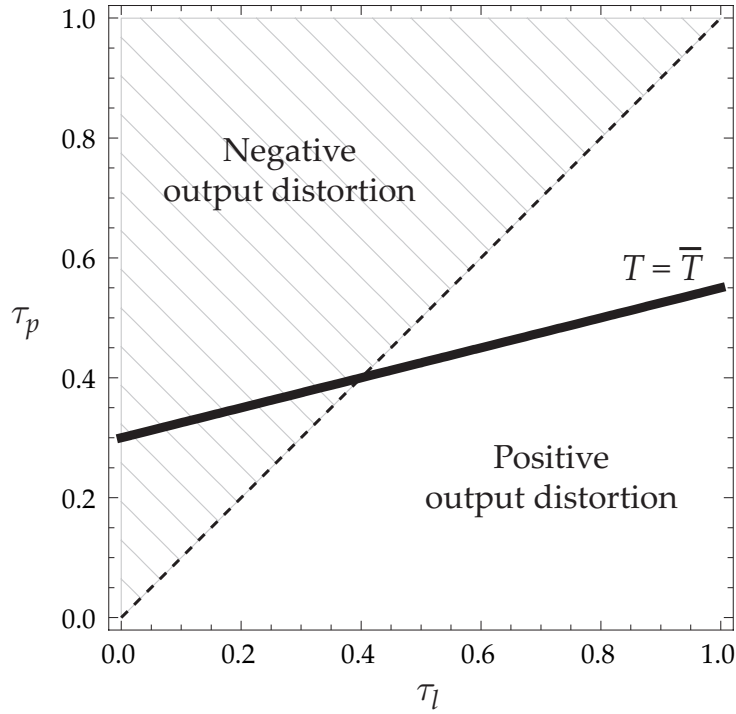


Figure 6.2: Space of possible tax tariffs  $(\tau_p, \tau_l)$ . Tariffs in the shaded region imply  $\Delta\tau < 0$  and therefore  $q_S^* < q^*$ , while tariffs in the non-shaded region imply  $\Delta\tau > 0$  and therefore  $q_S^* > q^*$ . Tariffs on the dashed line imply  $\Delta\tau = 0$  and therefore  $q_S^* = q$ . All tariffs on the solid black line yield a constant expected amount of taxes  $\bar{T}$ .

assume a tax authority wants to collect some specific positive expected tax revenue  $T = \bar{T} > 0$  from firm  $S$  that corresponds to some average tax rate  $\bar{\tau} = \bar{T}/E[\Pi]$ , where  $\bar{T} < E[\Pi]$  so that the firm's expected after-tax value is positive. Holding output constant, there is a set  $\mathbb{T} := \{(\tau_p^*, \tau_l^*) | T = \bar{T}\}$  of tariffs that yield exactly this expected tax revenue, that is, the set of tariffs  $(\tau_p^*, \tau_l^*)$  where expected tax revenue  $T$  is equal to

$$\tau_l^* \int_{-\infty}^z \pi(q, z) dF(z) + \tau_p^* \int_z^{\infty} \pi(q, z) dF(z) = \bar{T}. \quad (6.6)$$

Notice that for any given  $\bar{T}$  there are infinitely many tariffs  $(\tau_p^*, \tau_l^*)$  that satisfy (6.6), as depicted for an example in figure (6.2), where the implicit average tax rate is  $\bar{\tau} = 0.4$ . All tariffs in the shaded (non-shaded) region imply negative (positive) output distortions, and symmetric tariffs along the dashed 45 degree line involve no output distortion. The thick black line summarizes all tariffs that yield expected tax revenue  $\bar{T}$ , that is, all tariffs in the set  $\mathbb{T}$ . Some of these tariffs induce firms to produce more output than the benchmark quantity  $q^*$ , while others induce a negative output distortion. For example, consider the corner tariff  $(\tau_l^* = 0, \tau_p^* = 0.3)$  where tax offsetting is not allowed, so that there is no compensation for losses at all. Because of under-compensation firms will produce less than the benchmark quantity  $q^*$  if they are subjected to this tariff, this follows from proposition (6.1). Similarly, there is a tariff  $(\tau_l^* = 1, \tau_p^* = 0.55)$  with

full compensation for losses that yields  $\bar{T}$  as well, and since the tariff involves over-compensation, it induces firms to produce more than  $q^*$ . Last but not least, there is a unique symmetric tariff ( $\tau_l^* = \bar{\tau}, \tau_p^* = \bar{\tau}$ ) that involves no output distortion. In other words, to raise any given expected tax revenue, the tax authority can choose between tariffs that increase or decrease output, or have no effect on output at all. It follows that for any given  $\bar{T}$ , there is a welfare maximizing tariff that maximizes output, where welfare is the sum of expected consumer surplus, expected producer surplus and expected tax revenue. The empirically observed under-compensation for losses is obviously suboptimal in this respect, as another tariff could yield the same expected tax revenue at a higher level of output and therefore at a higher expected level of overall welfare.<sup>3</sup> A necessary but not sufficient condition for an optimal tariff is asymmetric taxation with over-compensation for losses.

To summarize, asymmetric taxation can induce both positive and negative output distortions, only a symmetric tariff has no distortionary consequences. The comparative statics of firms that are subjected to asymmetric taxation are radically different from symmetrically taxed firms. Most importantly, output depends on the riskiness of the product market environment, and on over- or under-compensation for losses. These results are of pivotal importance for the following analysis of financial synergies, as the main consequence of the merger is a reduction of risk.

### 6.3 Real Effects of Financial Synergies

Anecdotal evidence claims the expected tax payment of the merged firm  $M$  should be lower than the combined tax burden of separate firms in the presence of asymmetric taxation (eg Copeland et al., 2005). More formally, if  $V_S^*$  is the equilibrium market value of each stand-alone firm, and  $V_M^*$  the equilibrium market value of the merged firm  $M$ , then the expected value of financial synergies

$$\Delta V \equiv V_M^* - nV_S^* \quad (6.7)$$

is argued to be positive. As  $V_S^*$  was already derived in the previous section, it remains to derive the market value of conglomerate  $M$ . Just like in previous chapters, this problem can be framed conveniently in terms of a single “average” product market that is representative for the conglomerate’s overall portfolio of businesses. Ex post cash flow in this product market is  $\bar{\pi} = \pi(q, \bar{z})$ , where  $\bar{z}$  is the realization of the mean cash flow shock  $\bar{Z} = \sum_{i=1}^n Z_i n^{-1}$ , which is normally distributed with zero mean, standard

<sup>3</sup>Technically, the expected welfare maximizing tariff minimizes the tax rate differential  $\Delta\tau$ . For the example in figure 6.2 this is the corner tariff ( $\tau_L^* = 1, \tau_P^* = 0.55$ ).



	Imperfect correlation ( $\bar{\rho} < 1$ )		Perfect correlation ( $\bar{\rho} = 1$ )	
	Synergies	Quantities	Synergies	Quantities
Symmetric taxation	None ( $\Delta V = 0$ )	Constant ( $q^* = q_M^* = q_S^*$ )	None ( $\Delta V = 0$ )	Constant ( $q^* = q_M^* = q_S^*$ )
Under-compensation	Positive ( $\Delta V > 0$ )	Increase ( $q^* > q_M^* > q_S^*$ )	None ( $\Delta V = 0$ )	Constant ( $q^* > q_M^* = q_S^*$ )
Over-compensation	Negative ( $\Delta V < 0$ )	Decrease ( $q^* < q_M^* < q_S^*$ )	None ( $\Delta V = 0$ )	Constant ( $q^* < q_M^* = q_S^*$ )

Table 6.3: Summary of financial synergies and quantity effects with symmetric and asymmetric taxation.

deviation  $\bar{\sigma}$  and cumulative density function  $G(\cdot)$ .<sup>4</sup> Given perfectly symmetric product markets ( $q_i = q$ ), the problem of firm  $M$  is to find the symmetric quantity that solves

$$\max_q V_M = n \left[ (1 - \tau_l) \int_{-\infty}^{\hat{z}} \pi(q, \bar{z}) dG(\bar{z}) + (1 - \tau_p) \int_{\hat{z}}^{\infty} \pi(q, \bar{z}) dG(\bar{z}) \right], \quad (6.8)$$

where  $\hat{z} = c - p(q)$  is the critical realization of the mean shock at which total cash flow of firm  $M$  is exactly zero. The associated first order condition is

$$V'_M = n \left[ (1 - \tau_l) \int_{-\infty}^{\hat{z}} \frac{\partial \pi(q, \bar{z})}{\partial q} dG(\bar{z}) + (1 - \tau_p) \int_{\hat{z}}^{\infty} \frac{\partial \pi(q, \bar{z})}{\partial q} dG(\bar{z}) \right] = 0. \quad (6.9)$$

Let  $q_M^*$  be the equilibrium solution, and  $V_M^* = V_M(q_M^*)$  the corresponding expected equilibrium market value of firm  $M$ . As in previous chapters, this problem is qualitatively the same as the problem of each focused firm (6.4), except for multiplication by a constant ( $n$ ). Comparative statics established by propositions (6.1) and (6.2) therefore apply as well. The following proposition establishes a strong statement about the expected value of financial synergies:

**Proposition 6.3.** *If shocks are on average perfectly positively correlated there are no financial synergies. If shocks are imperfectly correlated there are positive (negative) financial synergies if the tax tariff exhibits under-compensation (over-compensation) for losses. The expected value of synergies increases (decreases) in the average correlation coefficient with under-compensation (over-compensation).*

Statements of this proposition are summarized in table (6.3). A necessary condition for non-zero financial synergies is the combination of markets that exhibit some de-

<sup>4</sup>Again, readers not familiar with this approach should consult section 3 of chapter 4.

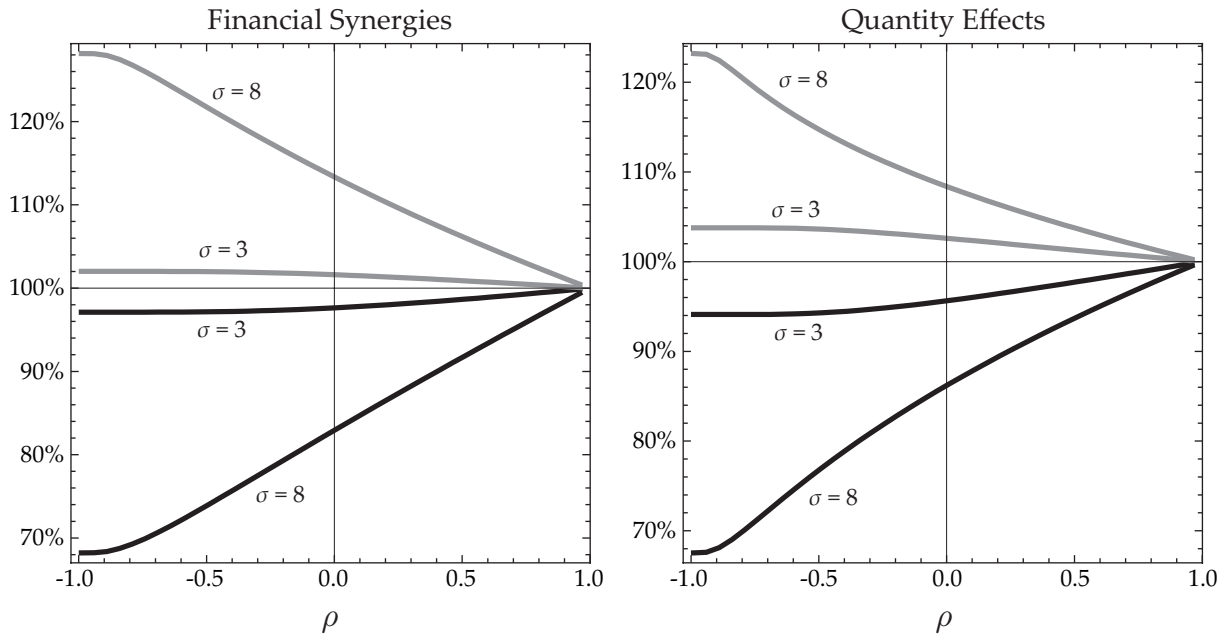


Figure 6.3: The usual numerical example with two markets ( $n = 2$ ), linear inverse demand  $p(q) = 10 - q$  and marginal cost  $c = 2$ . The left figure graphs  $V_M^*$  in percent of  $nV_S^*$  as a function of the correlation coefficient  $\rho$ , and the right figure graphs  $q_M^*$  in percent of  $q_S^*$ , again as a function of  $\rho$ , for high- and low-risk environments. In both figures gray schedules refer to a tariff with under-compensation for losses ( $\tau_l = 0, \tau_p = 0.4$ ) and black schedules capture over-compensation ( $\tau_l = 0.9, \tau_p = 0.4$ ).

gree of imperfect correlation and asymmetric taxation. Under-compensation or over-compensation for losses then determines the actual sign of the expected value of synergies. Intuitively, the basic consequence of asymmetric taxation is a link between the market value of the conglomerate and the riskiness in its representative product market: with  $\Delta\tau > 0$  the market value of firm  $M$  increases as the amount of risk decreases, and in the opposite case of  $\Delta\tau < 0$  the market value decreases if risk declines. Hence, since diversification implies there is strictly less risk in the average product market of the conglomerate than in individual markets of stand-alone firms, there are positive (negative) financial synergies in case of over-compensation (under-compensation) for losses. The absolute value of these synergies strictly decreases in the average correlation coefficient, so synergies become more significant as the average correlation of markets declines. The left part of figure (6.3) graphs the expected value of financial synergies for a simple numerical example. If cash flow volatilities are small synergies are relatively small as well, but can become quite substantial in more risky settings.

Importantly, these results suggest that firm owners and tax authorities have opposing preferences over the merger, since the value of positive (negative) financial synergies exactly equals the decrease (increase) in expected total revenue of the tax authority. Thus, whenever firm owners have incentives to merge, tax authorities would like to prohibit a merger, and vice versa. What about consumers? The merger's quantity

effects are summarized by the following proposition.

**Proposition 6.4.** *If shocks are on average perfectly positively correlated there are no quantity effects. Given imperfectly correlated shocks, under-compensation implies equilibrium output of the diversified firm is higher than output of each focused firm, and vice versa for over-compensation. The merger's quantity effect is the stronger the lower the average coefficient of correlation.*

Quantity effects are summarized in table (6.3) as well. Because of asymmetric taxation a merger of firms in completely unrelated markets has once more real consequences for equilibrium quantities. Since positive (negative) financial synergies imply a positive (negative) quantity effect of the merger, preferences of consumers and firm owners over specialization and diversification of firms are aligned, and there is no need for a competition authority to intervene. Eldor and Zilcha (2002) examine hedging of perfectly competitive firms in the context of under-compensation for losses and find a negative output distortion that is alleviated once firms are allowed to hedge against uncertainty. The present analysis corroborates these results, since diversification can be interpreted as a natural hedge against risk that reduces the negative output distortion of asymmetric taxation. The right part of figure (6.3) graphs quantity effects of a merger, which can be quite substantial in risky environments. With perfectly negatively correlated shocks hedging (diversification) removes all risk, and firms produce the benchmark quantity  $q^*$ .

What are overall implications for tax and competition policy? From the perspective of consumers, a tax authority that aims to collect some given amount of taxes should ideally choose a tariff that over-compensates for losses and is therefore associated with a positive output distortion ( $\Delta\tau < 0$ ). Firm owners will have no incentive to merge with such a tariff, so there is no need for regulation. Yet the alternative and empirically more relevant case is a tariff that features under-compensation for losses ( $\Delta\tau > 0$ ). Such a tariff is associated both with a negative output distortion and incentives to merge because of a positive financial synergy. Consumers benefit from a merger because of a positive quantity effect, so competition authorities should permit a merger. Yet positive financial synergies imply that — holding tax rates constant — the tax authority receives a lower expected total tax payment if firms merge. Therefore, if the authority designs a tariff with under-compensation so that it expects to collect a total tax revenue  $n\bar{T}$  from focused stand-alone firms, it will receive less than that in equilibrium since firms merge. The difference between anticipated and actual tax revenue equals the total value of financial synergies  $\Delta V > 0$ . Tax authorities should therefore anticipate merger incentives implicitly included in tax tariffs. Hence, although under-compensation for losses creates no conflict between firm owners and consumers, there is a conflict between competition and tax authorities: tax authorities prefer corporate

specialization, whereas the competition authority prefers if firms diversify.

## 6.4 Applications and Extensions

This section discusses applications and extensions of the above analysis, focusing on relations and connections to other chapters in this thesis. An alternative lump-sum tax tariff is examined that is the mirror image of fixed distress cost in chapter 5, strategic benefits associated with diversification are demonstrated, and results in this and other chapters are extended to more general stochastic assumptions.

### 6.4.1 Lump-Sum Taxation

The examination of distress costs in the previous chapter showed that financial synergies and associated real effects can be quite sensitive to the specification of the financial wedge that causes synergies. Results about asymmetric corporate taxation exhibit a similar sensitivity. For example, consider the lump-sum tariff

$$t = \begin{cases} m\bar{T} & \text{if } y \geq m\bar{T} \\ 0 & \text{if } y < m\bar{T} \end{cases} \quad (6.10)$$

where  $y$  is the value of cash flow,  $m$  the number of markets a firm is engaged in and  $\bar{T} > 0$  a fixed lump-sum tax fee per market, for example, an annual concession or license fee for the use of an entry barrier. A firm with  $m$  business units is thus required to pay a lump-sum  $m\bar{T}$  to the tax authority whenever its cash flow is greater than  $m\bar{T}$ , otherwise the firm is exempted from taxation. The tariff is clearly asymmetric, as it involves zero compensation for losses, and the associated valuation function is neither convex nor concave.

Even without a full-fledged analysis of tariff (6.10) some straightforward counterexamples to results obtained in the analysis of the proportional tariff (6.1) are readily available. One example is depicted in figure (6.4). A basic implication of the lump-sum tariff is that the diversified firm's probability of being exempted from tax payments tends to be lower than the probability of focused firms, which suggests that the diversified firm faces a higher expected tax payment. Financial synergies are thus negative, and there are no incentives to merge (instead there are incentives for securitization). Furthermore, as the gray schedule in the right part of figure (6.4) clearly shows, a lump-sum tariff can summon a conflict between firm owners and consumers, since negative financial synergies go hand in hand with positive quantity effects. Financial synergies depend on the cumulative probability of a tax exemption, which is strictly lower after a merger. Real effects depend in turn on marginal taxes, which may both

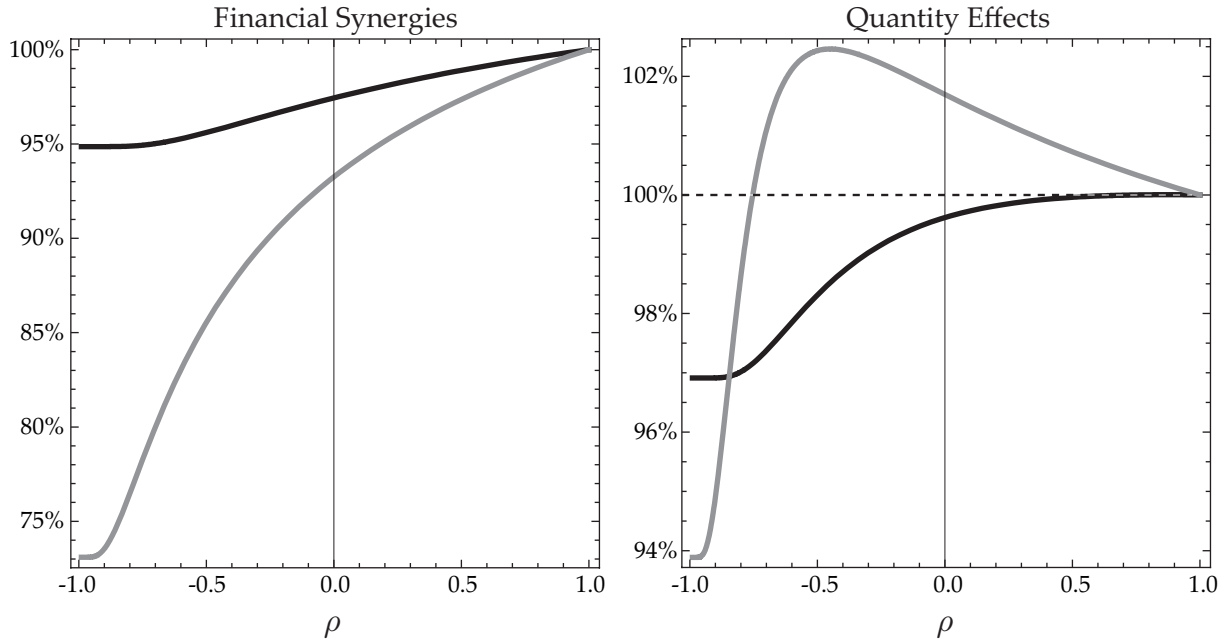


Figure 6.4: Numerical example of the alternative tariff (6.10) with two markets ( $n = 2$ ),  $p(q) = 10 - q$ ,  $c = 2$  and  $\sigma = 3$ . The left figure graphs  $V_M^*$  in percent of  $nV_S^*$ , and the right figure plots  $q_M^*$  in percent of  $q_S^*$ , both as functions of  $\rho$ . In both figures the gray schedule corresponds to a „high“ lump-sum tax ( $\bar{T} = 9$ ) and the black schedule to a „low“ tax ( $\bar{T} = 4$ ).

increase or decrease if firms merge. Hence there are settings where consumers would benefit from a merger, yet firm owners have no incentive to merge. Since expected welfare is strictly increasing in output there may be a rationale for policy intervention in this case, like, for example, a merger subsidy or tax relief. This is the reverse of the results obtained in the context of fixed distress cost in the previous chapter.

### 6.4.2 Strategic Benefits of Diversification

The analysis of limited liability identified strategic costs of diversification. The reverse of such costs are strategic benefits caused by real effects of financial synergies, which are demonstrated in this subsection. Explicitly, diversified firms can be more competitive than focused rivals in the presence of asymmetric corporate taxation that involves under-compensation for losses.

To see this, assume there is a single conglomerate  $M$  that serves all  $n$  product markets. In each market there is an independent focused stand-alone rival that competes with the conglomerate's business unit in quantities, so that there are  $n$  duopolistic product markets. Assume  $q_S$  is the quantity offered in each market by one of the symmetric focused firms, while  $q_M$  is the quantity offered in each market by the conglomerate  $M$ . Let  $\pi(q_j, q_{-j}, z_i) = \{p(Q) - c + z_i\}q_j$  be the cash flow of firm  $j$  in market  $i$ , given  $q_j$  and  $q_{-j}$  are quantities produced by firm  $j$  and its rival  $-j$ , respectively, so that total output in each market is  $Q = q_j + q_{-j}$ . It follows from (6.4) that the expected

market value of a representative focused firm  $S$  is

$$V^S = (1 - \tau_l) \int_{-\infty}^{\hat{z}} \pi(q_S, q_M, z) dF(z) + (1 - \tau_p) \int_{\hat{z}}^{\infty} \pi(q_S, q_M, z) dF(z), \quad (6.11)$$

where  $\hat{z} = c - p(Q)$  is the critical realization of the stand-alone firm's cash flow shock. Shock  $Z$  is distributed with cumulative density  $F(\cdot)$ , zero mean and standard deviation  $\sigma$ . Expression (6.8) in turn implies the market value of the conglomerate with its  $n$  business units is

$$V^M = n \left[ (1 - \tau_l) \int_{-\infty}^{\hat{z}} n\pi(q_M, q_S, \bar{z}) dG(\bar{z}) + (1 - \tau_p) \int_{\hat{z}}^{\infty} \pi(q_M, q_S, \bar{z}) dG(\bar{z}) \right] \quad (6.12)$$

where  $\hat{z} = c - p(Q)$  is the critical realization of the conglomerate's mean shock. Again, the mean shock  $\bar{Z}$  in the imaginary representative market is distributed with cumulative density  $G(\cdot)$ , zero mean and standard deviation  $\bar{\sigma}$ . Assuming firms engage in one-shot Cournot competition, the Nash equilibrium is determined by optimal quantities  $(q_S^*, q_M^*)$  that solve the system of first order conditions ( $V_S^S = 0, V_M^M = 0$ ). Equilibrium market shares are distributed as follows.

**Proposition 6.5.** *Perfect positive correlation ( $\bar{\rho} = 1$ ) or symmetric taxation imply that the conglomerate and its rivals evenly share each market ( $q_M^* = q_S^*$ ). Given less than perfectly correlated ( $\bar{\rho} < 1$ ) cash flows, equilibrium market shares of focused firms are strictly smaller (greater) than shares of the conglomerate if there is asymmetric taxation with under-compensation (over-compensation) for losses.*

Hence diversification across absolutely unrelated product markets can be a tough commitment in the terminology of Fudenberg and Tirole (1984). Any decrease in the average correlation coefficient of shocks pushes the conglomerate's reaction function outward and therefore increases the conglomerate's market share. Since quantities are strategic substitutes, rivals react with a contraction of output, and this reaction is a strategic benefit of diversification. This result is directly opposed to strategic cost of diversification identified in chapter 4 and elsewhere (eg Lyandres, 2007). Notice unilateral diversification is not a stable equilibrium in the presence of positive financial synergies. Firm  $M$ 's focused rivals have incentives to merge as well. Such a merger will push their combined reaction function outward, so that focused firms can increase their market share if they merge. The result is a symmetric bilaterally diversified equilibrium where subsidiaries of two diversified firms compete in  $n$  product markets and equally share each market.

### 6.4.3 General Uncertainty

The analysis in this and other chapters focused exclusively on normally distributed cash flows. This extension discusses whether results can be extended to more general stochastic assumptions. Using an approach introduced by Rothschild and Stiglitz (1970, 1971, RS in the following), conditions for financial synergies and associated real effects are established in the context of arbitrarily distributed cash flows.

Assume cash flow in market  $i$  depends on the realization  $\theta_i$  of a random shock  $\Theta_i$  that is distributed with zero mean and some arbitrary continuous distribution  $F(\cdot)$ . Let  $\bar{\theta}$  be the realization of the cash flow shock  $\bar{\Theta}$  in firm  $M$ 's representative product market, distributed with zero mean and distribution  $G(\cdot)$ . Assume that because of diversification firm  $M$ 's representative cash flow shock exhibits less risk than the cash flow of each focused firm.<sup>5</sup> Let  $v(\cdot)$  be a strictly non-decreasing valuation function that satisfies  $v(\alpha y) = \alpha v(y)$  for all positive constants  $\alpha$ . Focusing on symmetric equilibrium quantities, the expected value of financial synergies is (weakly) positive if

$$\int v(n\pi(q, \bar{\theta})) dG(\bar{\theta}) \geq n \int v(\pi(q, \theta)) dF(\theta), \quad (6.13)$$

that is, if the expected market value  $V_M$  of firm  $M$  (left-hand side) is weakly greater than the expected total market value of  $n$  stand-alone firms  $nV_S$  (right-hand side). If the inequality is reversed the expected value of financial synergies is (weakly) negative. Technically, this is a condition for second-order stochastic dominance of the distribution of cash flow in firm  $M$ 's representative market over the distribution of each stand-alone firm's cash flow.<sup>6</sup> RS showed that (6.13) holds for every increasing and concave (convex) function  $v(\cdot)$  if  $\bar{\Theta}$  exhibits less risk than  $\Theta$ . The following proposition summarizes this.

**Proposition 6.6.** *If  $v(\cdot)$  is concave (convex), then there are weak positive (negative) financial synergies.*

If the financial constitution of firms establishes a non-linear valuation function, then differences in risk translate to differences in market values. Intuitively, a concave or convex valuation function resembles the utility function of a risk-averse or risk-affine

<sup>5</sup>Explicitly, in the spirit of RS this means that  $\Theta$  is equal to  $\bar{\Theta}$  plus some noise, that is, assume there is a random variable  $Z_0$  such that  $\Theta$  has the same distribution as  $\bar{\Theta} + Z_0$ , where  $E[Z_0|\bar{\Theta}] = 0$  for all  $\bar{\Theta}$ . Equivalently, assume  $F(\cdot)$  is a mean-preserving spread of  $G(\cdot)$ , that is, that the density function  $f(\cdot)$  of  $F(\cdot)$  was obtained from density function  $g(\cdot)$  of  $G(\cdot)$  by taking some of the probability weight from the center of  $g(\cdot)$  and adding it to its tails in such a way as to leave the distribution's mean unchanged.

<sup>6</sup>Generally, for any two distributions  $G(\cdot)$  and  $F(\cdot)$  with the same mean and every non-decreasing concave function  $v : \mathbb{R} \rightarrow \mathbb{R}$ , if

$$\int v(y) dG(y) \geq \int v(y) dF(y),$$

then distribution  $G(\cdot)$  is said to second-order stochastically dominates (SSD) distribution  $F(\cdot)$  (for example, see Mas-Colell et al., 1995, p199).

individual. A risk-averse (risk-affine) individual is characterized by a utility function that is concave (convex) in wealth (eg Gollier, 2001), and ceteris paribus expected utility of risk-averse (risk-affine) agents decreases (increases) as the volatility of the agent's wealth increases. A convex or concave valuation function has similar consequences: if  $v(\cdot)$  is concave (convex), then expected market values decrease (increase) in the riskiness of cash flows. Technically, if  $v(\cdot)$  is concave (convex) the distribution of the diversified firm's mean cash flow second-order stochastically dominates (is dominated by) the distribution of each focused firm's cash flow.

Consider now real effects of financial synergies. Let  $q_S^*$  be the equilibrium quantity that solves the first-order condition  $V'_S = 0$  of a representative stand-alone firm  $S$ . There are positive real effects of financial synergies if firm  $M$ 's first-order condition  $V'_M = 0$  is positive at  $q = q_S^*$ , that is, in case

$$\int \frac{\partial v(\pi(q, \bar{\theta}))}{\partial q} dG(\bar{\theta}) \Big|_{q=q_S^*} \geq \int \frac{\partial v(\pi(q, \theta))}{\partial q} dF(\theta) \Big|_{q=q_S^*}. \quad (6.14)$$

To see why, notice that the right-hand side certainly equals zero from the definition of  $q_S^*$ . If firm  $M$ 's first-order condition on the left-hand side is positive at  $q_S^*$ , it follows that firm  $M$  needs to increase its output to achieve equilibrium, it needs to produce more output than firm  $S$  in equilibrium, since first-order conditions are globally decreasing in output. In the opposite case where firm  $M$ 's first-order condition is negative at  $q_S^*$  it will produce less output than firm  $S$  in equilibrium. Now, proposition (6.6) suggests inequality (6.14) indeed holds if first-order conditions of firm's are concave functions of cash flow shocks, and that the inequality is reversed if first-order conditions are convex in shocks. Quantity effects of financial synergies therefore depend on the impact of shocks on first-order conditions. Generally, if conditions are non-linear in shock realization, then equilibrium quantities are sensitive to specialization and diversification. More precisely, if first-order conditions are concave (convex) in shocks, firm  $M$  produces more (less) than focused firms.

Returning to figure (6.1) at the beginning of this chapter, the tax rate differential clearly determines convexity or concavity of the valuation function. In case  $\Delta\tau > 0$  the market value is a concave function of asset values, whereas  $\Delta\tau < 0$  implies convexity, associated with positive and negative financial synergies, respectively. Similarly, expression (6.9) shows that convexity and concavity of firm  $M$ 's first-order condition depend on the tax rate differential as well. If  $\Delta\tau > 0$  the condition is concave, which implies a positive quantity effect, and vice versa for  $\Delta\tau < 0$ . The only stochastic assumption necessary for this result is that firm  $M$ 's average cash flow exhibits less risk in the spirit of RS.

In a similar fashion many results of this thesis can be formulated in terms of convexity or concavity of the valuation function. For example, limited liability implies



the valuation function is convex, and expected financial synergies are therefore negative. First-order conditions are convex in shock realizations, so quantity effects are negative as well. Proportional distress cost in turn imply a concave valuation function that summons positive financial synergies and positive quantity effects. Yet not all valuation functions examined in this thesis are convex or concave. For example, fixed distress cost that were examined in the previous chapter imply a valuation function that is neither convex nor concave. Similarly, the valuation function with lump-sum taxation is neither convex nor concave.

## 6.5 Summary

This chapter examined financial synergies and associated real effects caused by asymmetric taxation of corporate profits and losses. Consequences of such asymmetric taxation depend on over- or under-compensation for losses. The empirically relevant case of under-compensation implies a negative output distortion, positive financial synergies, and positive real quantity effects. Preferences of consumers and firm owners are aligned, as firms produce more output if they merge. Yet there is a conflict between competition and tax authorities: competition authorities welcome a merger, but tax authorities prefer *ceteris paribus* a focused equilibrium where expected tax revenue is higher. Over-compensation for losses has reverse consequences. Applications and extensions showed these results are quite sensitive to the specification of the tax tariff (proportional vs. lump-sum), but fairly robust to more general stochastic assumptions. Furthermore, asymmetric taxation implies that diversification does not necessarily entail strategic costs, but may instead improve the competitiveness of firms.

## 6.6 Proofs

### Proposition 6.1

*Proof.* In case of symmetric marginal tax rates  $\tau_p = \tau_l = \bar{\tau}$  the first-order condition of a taxed firm becomes

$$(1 - \bar{\tau}) \left[ \int_{-\infty}^{\hat{z}} \frac{\partial \pi(q, z)}{\partial q} dF(z) + \int_{\hat{z}}^{\infty} \frac{\partial \pi(q, z)}{\partial q} dF(z) \right] = 0.$$

The solution depends only on the sum in brackets. This sum is the expected value of cash flow, which is maximized by the benchmark quantity  $q^*$ . First-order condition (6.5) suggests that with  $\Delta\tau > 0$  there is relatively more weight on “bad” states of the world, which requires lower output relative to  $q^*$ , while  $\Delta\tau < 0$  puts more weight on

“good” states of the world, so equilibrium output is greater than  $q^*$ .  $\square$

### Proposition 6.2

*Proof.* The derivative of the reduced form of the after-tax market value  $V_S^* = V_S(\sigma, q_S^*(\sigma))$  with respect to  $\sigma$  is

$$\frac{dV_S^*}{d\sigma} = \frac{\partial V_S}{\partial \sigma} + \left( \frac{\partial q_S^*}{\partial \sigma} \right) V_S'.$$

The second term is zero since the first-order condition  $V_S' = 0$  is satisfied at  $q_S^*$  (the envelope theorem). The sign of  $(dV_S^*/d\sigma)$  is therefore determined by the first term, which after substitution of the normal distribution’s probability density function turns out to be

$$\frac{\partial V_S}{\partial \sigma} = -\sigma f(\hat{z})q(\tau_p - \tau_l)$$

and therefore depends on the sign of the tax rate differential  $\Delta\tau$ . Implicit differentiation of first-order condition (6.5) with respect to  $\sigma$  reveals

$$\frac{\partial q_S^*}{\partial \sigma} = \frac{f(\hat{z})(\tau_p - \tau_l)(\sigma^2 + \hat{z}qp'(q))}{V_S''},$$

which is negative for  $\Delta\tau > 0$  and positive for  $\Delta\tau < 0$ . Finally, implicit differentiation of (6.5) with respect to marginal tax rates yields

$$\begin{aligned} \frac{\partial q_S^*}{\partial \tau_p} &= \frac{\int_{\hat{z}}^{\infty} \frac{\partial \pi(q,z)}{\partial q} dF(z)}{V_S''} < 0, \\ \frac{\partial q_S^*}{\partial \tau_l} &= \frac{\int_{-\infty}^{\hat{z}} \frac{\partial \pi(q,z)}{\partial q} dF(z)}{V_S''} > 0. \end{aligned}$$

Therefore output increases in the tax rate on losses and decreases in the tax rate on profits.  $\square$

### Proposition 6.3

*Proof.* If  $\bar{\rho} = 1$  then  $Z_i$  and  $\bar{Z}$  follow exactly the same distribution, so  $V_M^* = nV_S^*$  and therefore  $\Delta V = 0$ . Starting at  $\bar{\rho} = 1$ , any decrease in  $\bar{\rho}$  will decrease  $\bar{\sigma}$ . If  $\Delta\tau > 0$  it follows from proposition (6.2) that  $(dV_M^*/d\bar{\sigma}) < 0$ , so  $\Delta V > 0$ . Similarly, if  $\Delta\tau < 0$  it follows that  $(dV_M^*/d\bar{\sigma}) > 0$ , so that  $\Delta V < 0$ .  $\square$

### Proposition 6.4

*Proof.* If  $\bar{\rho} = 1$  then first-order conditions (6.5) and (6.9) are solved by the same quantities. The impact of a merger on quantities is therefore determined by the impact of a

decrease in  $\bar{\rho}$  on (6.9). It follows from proposition (2) that this effect depends on the tax rate differential  $\Delta\tau$ .  $\square$

### Proposition 6.5

*Proof.* It follows from proposition (6.4) that at  $\bar{\rho} = 1$  equilibrium quantities of specialized and diversified firms are identical ( $q_S^* = q_M^*$ ), since the objective function of the conglomerate (6.11) equals the objective function of each focused firm (6.12), except for multiplication by a constant. Total differentiation of the system of first-order conditions, subsequent division of the result by  $d\bar{\rho}$ , restatement in matrix notation and application of Cramer's rule yields

$$\begin{aligned} \frac{\partial q_M^*}{\partial \bar{\rho}} &= -\frac{V_{M\bar{\rho}}^M V_{SS}^S}{H} \begin{matrix} \leq \\ \geq \end{matrix} 0 \quad \text{for } \Delta\tau \begin{matrix} \geq \\ \leq \end{matrix} 0 \\ \frac{\partial q_S^*}{\partial \bar{\rho}} &= \frac{V_{M\bar{\rho}}^M V_{SM}^S}{H} \begin{matrix} \leq \\ \geq \end{matrix} 0 \quad \text{for } \Delta\tau \begin{matrix} \leq \\ \geq \end{matrix} 0 \end{aligned}$$

since  $H = V_{MM}^M V_{SS}^S - V_{SM}^S V_{MS}^M > 0$  is the usual Cournot stability condition (downward sloping reaction functions),  $V_{M\bar{\rho}}^M \begin{matrix} \leq \\ \geq \end{matrix} 0$  as  $\Delta\tau \begin{matrix} \geq \\ \leq \end{matrix} 0$  (see proposition 6.4),  $V_{SS}^S < 0$  (second-order condition) and  $V_{SM}^S < 0$  (quantities are strategic substitutes). Therefore, if  $\bar{\rho} < 1$  then  $q_S^* > q_M^*$ .  $\square$

### Proposition 6.6

*Proof.* The proof establishes a second-order stochastic dominance relation between the distributions of cash flows of focused firms and the average cash flow of firm  $M$ . Let  $Z_0$  be a random variable with zero mean and the property that  $\Pi$  and  $\bar{\Pi} + Z_0$  have exactly the same distribution, given that  $E[Z_0|\bar{\Pi}] = 0$ . One can now apply Jensen's inequality for conditional expectations (Karlin and Taylor, 1975, p249), which states that if  $v(\cdot)$  is concave, then  $E[v(\Pi)|\bar{\Pi}] \leq v(E[\Pi|\bar{\Pi}])$ , where the weak inequality is reversed if  $v(\cdot)$  is convex. Recall that  $\bar{\Pi} + Z_0$  is assumed to have exactly the same distribution as  $\Pi$ , so one may substitute  $\bar{\Pi} + Z_0$  for  $\Pi$  on the right-hand side of this inequality, which yields  $v(E[\bar{\Pi} + Z_0|\bar{\Pi}]) = v(\bar{\Pi})$ . Taking expectations of both sides yields  $E[E[v(\Pi)|\bar{\Pi}]] \leq E[v(\bar{\Pi})]$ , where iterated application of the expectations operator suggests  $E[E[v(\Pi)|\bar{\Pi}]] = E[v(\Pi)]$  on the left-hand side. Hence, if  $v(\cdot)$  is concave, it follows that  $nE[v(\Pi)] \leq E[v(n\bar{\Pi})]$ , which is equivalent to (6.13), and if  $v(\cdot)$  is convex then  $nE[v(\Pi)] \geq E[v(n\bar{\Pi})]$ .  $\square$

# Chapter 7

## Conclusions

The core result and quintessence of this thesis is that purely financial synergies may harm consumers. Seemingly innocuous financial aspects of mergers and acquisitions — for example, whether several separate legal entities are swapped for a single one in the process, or whether cash flows of merging firms are positively or negatively correlated — are therefore potentially important for the assessment of unilateral effects by competition authorities. The recent financial crisis that is deeply related to the surge in securitization supports this conclusion.

Findings of previous chapters are summarized in table 7.1, where specific causes for financial synergies are related to the four possible combinations of expected values of financial synergies (positive or negative) and directions of quantity effects (increase or decrease). As it turns out, financial synergies can summon all four outcomes, at least in theory. Concave (convex) valuation functions tend to yield strictly positive (negative) financial synergies and positive (negative) quantity effects. Valuation functions that are neither convex or concave (fixed distress cost and lump-sum taxation) have more ambiguous consequences and often imply a conflict between firm owners and

	Positive synergies ( $\Delta V > 0$ )	Negative synergies ( $\Delta V < 0$ )
Merger increases output	Asymmetric proportional taxation with under-compensation for losses; fixed and proportional distress cost.	Asymmetric lump-sum taxation.
Merger decreases output	Fixed distress cost in a high-risk environment where merging firms exhibit highly correlated cash flows.	Limited liability; asymmetric lump-sum taxation; asymmetric proportional taxation with over-compensation for losses.

Table 7.1: Different Combinations of Synergies and Quantity Effects

consumers, especially in settings where cash flows are very volatile: either firm owners try to engage in a merger that harms consumers, or consumers would benefit from a merger that is not profitable for firm owners. Such conflicts can establish a rationale for regulation and competition policy. Generally, a necessary condition for non-zero synergies and real effects is that cash flows are imperfectly correlated. With perfect correlation there are no financial synergies and no real effects. Similarly, strictly linear valuation functions are a sufficient condition for zero synergies and no real effects, and therefore for the irrelevance of corporate specialization and diversification.

The theoretical framework used to derive these results was simple: a single period, no agency-problems, symmetric information, quantity-setting monopolies, completely unrelated assets, downward-sloping demand, and normally distributed and observable cash flows. Given the plethora of results in table 7.1, this simplicity is an appealing feature of the analysis. Yet, at the end of this thesis, consider three promising extensions that address important limitations of this simple framework.

First, it was (implicitly) assumed throughout the analysis that a single legal entity arises from the merger. But in reality merging firms often keep their separate legal status. A diversified firm that owns subsidiaries with separate legal status is called a business group or holding (Cestone and Fumagalli, 2005). In the present context, separate legal status of a business group's subsidiaries offers several advantages, for example, negative financial synergies associated with limited liability can be avoided. Moreover, business groups can shift funds between subsidiaries to avoid a unit's distress or to minimize expected tax payments. An extended model should allow diversified firms to choose whether to equip subsidiaries with separate legal status or not.<sup>1</sup>

Second, another limitation of the analysis is the exclusive focus on corporate diversification. Generally, financial synergies may arise in every merger or acquisition where assets exhibit imperfectly correlated cash flows. Another natural extension would therefore examine real effects of financial synergies in the context of horizontal and vertical mergers. An interesting question is whether financial synergies can outweigh or reverse well-known non-financial implications of such mergers, for example, avoidance of double-marginalization, or internalization of a competitive externality (Salant et al., 1983).

Third and finally, the analysis was limited in the sense that each synergy cause has been examined individually and in isolation. As the financial constitution of almost every firm involves all three causes, a natural extension is a unified model that incorporates limited liability, distress costs and asymmetric taxation simultaneously. Such a unified model, properly calibrated to match empirical data, would be a first step to-

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<sup>1</sup>Similarly, the valuation function itself was not affected by the merger, which implicitly suggests financial constitutions of firms are not altered in the merger process, which is of course another simplifying assumption.

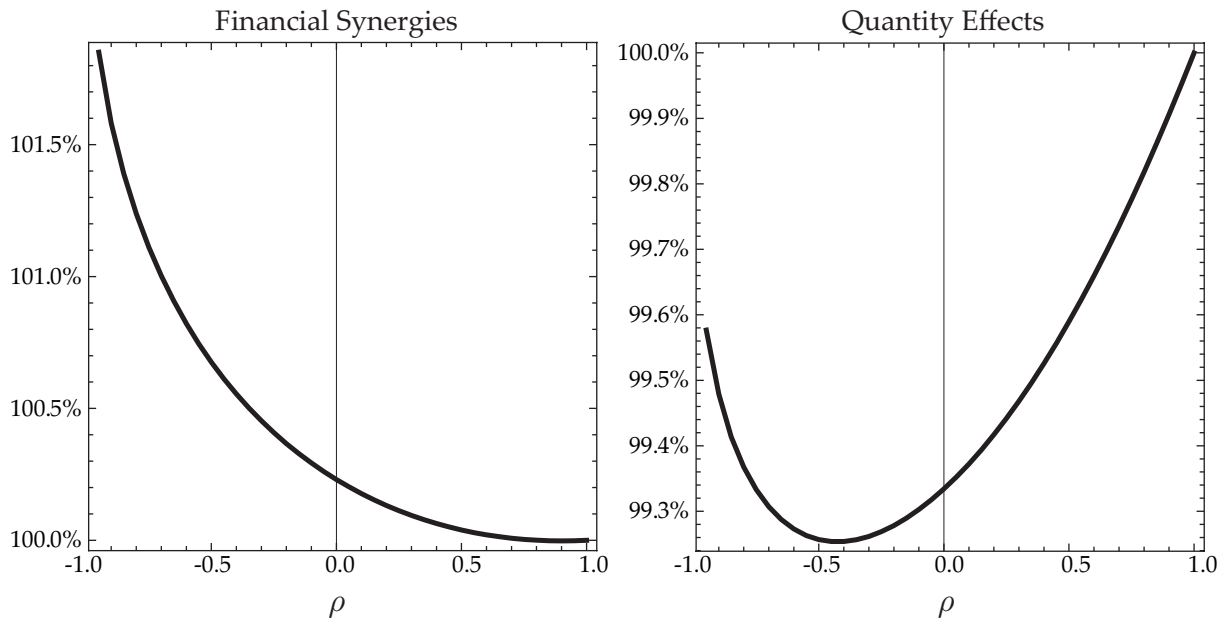


Figure 7.1: Extension of Leland (2007) with endogenous cash flows given by expression (7.1) and original parameter values. New parameters  $a$ ,  $c$  and  $\sigma_Z$  are calibrated to match the base case merger on p782 in Leland (2007), that is,  $a = 22.6$ ,  $c = 0$  and  $\sigma_Z = 4.39$ . The left figure graphs the expected market value of the merged firm over the total expected market value of focused firms (financial synergies), whereas the right figure graphs post-merger output over pre-merger output (quantity effects), in both figures as functions of the correlation coefficient of cash flows.

wards a more applicable theory of financial synergies and associated real effects.<sup>2</sup> Yet the central result of this thesis that positive financial synergies may harm consumers can be obtained in such a richer and more complex model as well. The following example briefly demonstrates this.

Leland (2007) examines a theoretical merger of two unrelated leveraged firms, where financial synergies are caused by limited liability, proportional distress cost and asymmetric corporate taxation. In his model firm owners choose optimal capital structures (leverage ratios) that maximize the total expected value of equity and debt, both before and after a merger. Optimal capital structures are determined according to the trade-off theory of leverage that dates back to Kraus and Litzenberger (1973): tax-deductible interest expenses and distress cost of leverage imply firms choose interior debt levels in equilibrium. As usual in the literature on financial synergies, there are by assumption no real effects in this model: cash flows generated by assets are normally distributed with exogenous mean and variance. Examining a numerical specification of this model that is carefully calibrated to match empirical data, results indicate that financial synergies can be both negative and positive, where the actual value depends significantly on asymmetries between merging firms.

<sup>2</sup>Such a unified model would also allow a thorough study of optimal horizontal boundaries (see chapter 5).

It is relatively easy to introduce ad hoc product markets into this model. In the original notation of Leland (2007), cash flow  $X_i$  that originates from focused firm  $i = 1, 2$  is simply normally distributed with mean  $Mu_i$  and standard deviation  $SD_i$ , that is,  $X_i \sim N(Mu_i, SD_i)$ . Now, to introduce endogenous cash flows that depend on the behavior of firms just like in the merger model of this thesis, assume cash flow of asset  $i$  is given by

$$X_i = \{p(q_i) - c + Z_i\}q_i, \quad (7.1)$$

where  $Z_i \sim N(0, \sigma_Z)$  is a shock to marginal cash flow and  $p(q_i) = a - q_i$  linear inverse demand. In an extended version of Leland (2007) cash flow  $X_i$  is thus distributed with moments

$$Mu_i = \{a - q_i - c\}q_i, \quad (7.2)$$

$$SD_i = q_i\sigma_Z, \quad (7.3)$$

so that output choices of firms affect the expected value and variance of cash flows. Firm owners not only choose capital structures in this extended specification, but production quantities as well, which suggests there are now two choice variables in the optimization problem. Even though a full fledged analysis of this extension is beyond the scope of this chapter, consider a few basic results.<sup>3</sup> Choosing parameter values that match the base case merger in the original calibrated specification of the model (p782, Leland, 2007), figure 7.1 plots the expected value of financial synergies and associated quantity effects. Interestingly, similar to the analysis of fixed distress cost in chapter 5 and lump-sum taxation in chapter 6, there is a conflict between firm owners and consumers. Synergies are relatively small but strictly positive. Irrespective of the coefficient of correlation, a merger involves a small but consistent reduction of output, so there is a strictly negative quantity effect and therefore a conflict between firm owners and consumers. Since the valuation function implicit in the analysis of Leland (2007) is convex in some sections and concave in others, this is not surprising.

The main conclusion from this example is that many disturbing and counterintuitive results about financial synergies derived in the very simple framework of this thesis can be obtained as well in much more complex unified models. Albeit at higher cost.

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<sup>3</sup>A MATHEMATICA algorithm that solves this extended model is available from the author upon request.

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