



# An Examination of the Relationship Between Firm Size, Growth and Liquidity in the Neuer Markt

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## **Abstract**

With the increasing competitive importance of scientific innovations associated with the new economy it has become critical to understand the dynamics of its' firm growth during this early and potentially critical stage of development. This study analyses the relationship between firm size and growth for Neuer Markt firms from its inception in 1997 until 2000. Evidence supports the hypothesis that smaller firms on the Neuer Markt grew faster than larger firms. Further, by using an alternative specification for growth, this study provides evidence that liquidity constraints impact firm growth, even when controlling for firm size and age. Results further indicate that while smaller firms grew faster in the new economy, larger firms grew faster in the old economy, supporting the notion that smaller German firms may be playing a larger role than previously in bringing new technologies to the market place.

## **Zusammenfassung**

Angesichts der zunehmenden Bedeutung wissenschaftlicher Innovationen , die mit der "neuen Ökonomie" in Verbindung stehen, ist es wichtig geworden, die Wachstumsdynamik dieser Firmen in einem frühen und möglicherweise entscheidenden Entwicklungsstadium zu verstehen. Dieses Papier untersucht für Firmen am Neuen Markt die Beziehung zwischen Größe und Wachstum in der Zeit von 1997 bis 2000. Es gibt Hinweise, dass kleinere Firmen am neuen Markt stärker wachsen als große Unternehmen.. Desweiteren gibt es nach dieser Studie Anzeichen, dass Liquiditätsbeschränkungen das Firmenwachstum beeinflussen, selbst wenn man für Größe und Alter kontrolliert. Weiterhin wird nahegelegt, dass kleine Firmen in der "neuen Ökonomie" schneller als große Firmen wuchsen, während in der "alten Ökonomie" das umgekehrte galt. Dies unterstützt die Vorstellung, dass kleinere deutsche Firmen heute möglicherweise eine größere Rolle als früher spielen, wenn es darum geht, neue Technologien auf den Markt zu bringen.

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# **An Examination of the Relationship Between Firm Size, Growth, and Liquidity in the Neuer Markt \*)**

## **I Introduction**

### ***The Link Between New Economy Growth and the Neuer Markt***

Growth of the new economy has become an increasingly important concern not only because of the scientific innovation associated with new economy firms and industries, but also because of their role as a source of employment. By empirically examining how the size-growth relationships work within the context of Germany, focusing on the Neuer Markt firms, this study hopes to improve our understanding of the new economy in general and shed light on strategic directions for economic policies aimed at optimal firm growth.

Since there is no generally agreed upon definition of the new economy let us begin by characterising new economy firms as those firms whose primary line of business is the development or application of information or knowledge, in contrast to old economy firms whose main line of business is the production of a physical asset or service.<sup>1</sup>

It is a stylised fact that while much of the new economy growth in the US was funded from the equity markets via the NASDAQ, Germany's introduction of the Neuer Markt in 1997 was an attempt to provide equity support to fuel Germany's smaller new economy firms. The importance of examining the link between equity markets and new economy growth is attracting increasing attention by policy makers and scholars alike. In fact there are a number of interesting implications of this link that might shed some light on the process of financing innovation.

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<sup>1</sup> These definitions of new economy and old economy roughly follow those of Larry Summers, former Secretary of the Treasury of the US. Audretsch (2001) also provides a useful definition of the new economy as one with four central characteristics: 1) globalization, 2) the shift to knowledge and ideas as a source of competitive advantage, 3) the increased importance of regional agglomerations and clusters, and 4) the emergence of entrepreneurship as an engine of growth and development.

New economy firms are different from old economy firms in two main ways that impact the size-growth relationship. First they tend to be younger and therefore more likely to be at an earlier stage in their development or firm life cycle. Life cycle theory suggests that younger/smaller firms will grow faster until they reach some critical or sustainable size. Second, since they are smaller and younger, they also tend to have more limited access to capital and capital markets than larger and older established firms in the economy. One contribution of this approach is to explicitly control for both firm size and liquidity in the model. By partitioning the size effect it is hoped that we can better understand *why* smaller firms may grow faster than their larger counterparts, as well as answer why we may observe differences in the dynamics of the size-growth relationship between the old and new economies.

This research will address these issues by testing 3 refutable hypotheses regarding the growth behaviour of firms in the new economy: 1) smaller firms grow faster than larger firms 2) the relationship between firm size and growth is independent of firm liquidity constraints and 3) new economy firms grow faster than old economy (high-technology) firms.

### ***Growth Theory and Gibrat's Law***

Interest in establishing or refuting the empirical validity of the *Law of Proportional Effect*, or what has become known as *Gibrat's Law* has exploded in recent years. In his comprehensive survey on "Gibrat's Legacy", Sutton (1997) interprets the Law as an "expected value of the increment firm's size in each period is proportional to the current size of the firm." Or as Mansfield (1962) articulated, "it is the probability of a given proportionate change in size during a specified period being the same for all firms regardless of their size at the beginning of the period."<sup>2</sup>

Earlier studies (Evans, 1987; Hall, 1987) suggest that Gibrat's Law does not always hold, and present some evidence of a negative relationship between firm size and growth for US firms. Recent studies that have concluded that initial firm size does impact firm growth in Germany include Wagner (1992), Reid (1995), Harhoff, Stahl, and Woywode (1998), Weiss (1998), Audretsch (1995), Audretsch and Weigand (1999), and Almus and Nerlinger (2000). More recently, Audretsch and Elston (AE)(2001) suggest that rather than just asking whether Gibrat's law holds or not, one should rather ask under which context it may hold.

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<sup>2</sup> For other excellent survey articles on growth see: Wagner 1992, Geroski 1995, Schmidt 1995, Klomp 1996, and Caves 1998.



This paper will build on this approach by examining the circumstances under which initial size may effect growth in Germany's new economy sector, controlling for industry, age, accounting year, and liquidity constraints of the firm for various firm groupings. The second section of the paper will discuss the empirical growth model. The data and measurement issues are explained in the third section. In the fourth section the empirical results are presented and discussed. Finally, in the fifth section a summary and conclusions are provided.

## II Empirical Growth Model

In his survey article on growth, Sutton (1997) suggests that while the number of employees is often used to measure growth, there are other less explored alternative measures such as growth of firm sales or physical assets may also be appropriate means of determining firm growth.<sup>3</sup> In this study I propose that while these definitions may be true equivalents for old economy firms, for new economy firms, the more appropriate growth measure should be based on the number of employees due to the relative scarcity of tangible or physical assets of new economy firms.

Formalizing the relationship between size and growth, Gibrat's law implies that the present size of firm  $i$  in period  $t$  may be decomposed into the product of a "proportional effect" and the initial firm size as:

$$\text{Size}_{i,t} = (1 + \varepsilon_t) \text{Size}_{i,t-1}$$

where  $(1 + \varepsilon_t)$  denotes the proportional effect for firm  $i$  in period  $t$ . Here the random shock  $\varepsilon_t$  is assumed to be identically and independently distributed. Taking the natural log and using the fact that for small  $\varepsilon$ ,  $\ln(1 + \varepsilon) \approx \varepsilon_t$ , we derive the following relationship,

$$\ln(\text{Size}_{i,t}) = \ln(\text{Size}_{i,0}) + \sum_{k=1}^t \varepsilon_{ik}$$

which as  $t \rightarrow \infty$  results in a distribution which is approximately log normal with properties that  $\ln(\text{Size}_{i,t}) \sim N(\mu_\varepsilon, t\sigma_\varepsilon^2)$ .<sup>4</sup>

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<sup>3</sup> See Sutton (1997).

<sup>4</sup> Almus and Nerlinger (2000) confirm this distributional assumption via kernel density estimates for German firms 1990-1996.

Firm growth can then be measured as the difference between the log of the number of employees as:

$$\text{Growth}_{i,t-n} = \ln(S_{i,t}) - \ln(S_{i,n}) / (t-n)$$

where  $\text{Growth}_{it}$  is measured by the difference in size for firm  $i$  between the current period  $t$  and the initial period  $n$ , generally one year in this study.

Based on Hall (1987) and Evans (1987) the empirical growth equation for testing the hypothesis that initial firm size impacts firm growth can be specified:

$$(1) \quad \text{Growth}_{i,t-n} = B_1 \ln(\text{Size}_{i,n}) + B_2 \ln(\text{Size}_{i,n})^2 + B_3 \ln(\text{Age}_{i,n}) + \varepsilon_{it}$$

where growth is a function of initial firm size,  $\text{size}^2$ , age, and  $\varepsilon_{it}$  a stochastic error term.

An alternative model which controls other factors related to growth including firm liquidity, variations in accounting year reporting, and industry effects can be specified as:

$$(2) \quad \text{Growth}_{i,t-n} = B_1 \ln(\text{Size}_{i,n}) + B_2 \ln(\text{Size}_{i,n})^2 + B_3 \ln \text{Age}_{i,n} + B_4 \ln \text{CF}_{i,n} + B_5 D_{\text{acctg}} + B_6 D_{\text{ind}} + \varepsilon_{it}$$

where growth for firm  $i$  in period  $t-n$  is a function of initial firm size,  $\text{size}^2$ , age -which I measure by the number of years since the firm's initial public offering (initial public offering), CF or net revenues represents the proxy for the liquidity constraints of the firm in the initial period  $n$ , and  $\varepsilon_{it}$  a stochastic error term. We can also control for industry effects by using a vector of industry dummies  $D_{\text{ind}}$ , and a vector of interactive dummies which controls for both macro shocks and accounting year differences in annual reports  $D_{\text{acctg}}$ . Dummies for accounting year scheme were constructed because some firms reported annual figures for a January-December accounting year while 70 other firms had "other" accounting years including July-June. For firms with an end of calendar year reporting schedule one set of time dummies was created for each year, and for firms with any other than an end of year reporting schedule, another set of time dummies were created for each year. Regressions were run without an intercept term to account for the inclusion of these mutually exclusive dummies in the model.

Because of the possibility of non-linearity in the size-growth relationship we may include a quadratic term in the model per Evans (1987) or Hall (1987). However this effects our measurement and interpretation of the impact of size on growth, because the non-linear function may be negative, zero, or positive depending where the function is measured. It

may be therefore informative to examine the average effect of firm size on growth by evaluating the derivative of equation (2) at the sample mean firm size in order to examine the effect of size on growth for the average firm in the sample where  $d(\text{Growth}_{i,t-n})/d(\text{Size}_{i,n}) |_{\text{mean size}} = d [B_1 \ln (\text{Size}_{i,n}) + B_2 \ln (\text{Size}_{i,n})^2 + \dots + \varepsilon_i] / d(\text{Size}_{i,n})$ .

### ***Liquidity Constraints***

Firm cash flows are used as a proxy of liquidity constraints of the firm in much the same way that they are introduced on the right-hand-side of the empirical investment models in the literature.<sup>5</sup> The rationale for these models being that once we move away from the perfect capital markets world, we find that financial and real decisions are not always separable for the firm. Liquidity problems, often exacerbated by asymmetry in information between suppliers of finance and firms for example, will influence real firm decisions such as investment in capital or labour –and by definition then, firm growth as measured by such. We expect these problems to be particularly severe for smaller and younger firms with limited access to capital and capital markets and little in the way of physical capital with which to secure debt. In this model then we would predict that both the cash flow and size effects to be particularly pronounced for the smaller firms in the sample.

In effect this research blends two strands of the economics literature, that of the growth literature and that of the investment-liquidity literature. In the investment-liquidity literature the impact of liquidity constraints on investment or essentially capital stock growth is examined, while I propose analysing the impact of liquidity constraints on employment growth.

The purpose of including a measure of firm liquidity into the regression is two-fold. First, by adding this measure we are able to examine the degree to which a firm's growth is impacted by liquidity constraints. A second interpretation however is that by holding liquidity constraints constant, we can focus on the relationship of interest –that of firm size to growth, controlling for the liquidity constraints of the firm. We are able then to separate out the size effects into two pieces, those which stem from “financial” effects and those from “other” size effects. This will allow us to distinguish then whether firm size may promote growth simply because larger firms 1) have better access to capital or larger cash reserves or 2) are in latter stages of their life-cycle where they have advantages of economies of scale or scope.

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<sup>5</sup> For detailed description of the theoretical and empirical underpinnings of the liquidity constrained investment models see for example, Hoshi, Kashyap, and Scharfstein, (1991), Elston (1993), Bond and Meghir (1994) or Fazzari, Hubbard and Peterson (1988).

Another way that the new economy is purported to be different is the time a firm takes from incorporation to initial public offering. Jovanovic and Rousseau (2001) show that young firms entering the NYSE, AMEX, and the NASDAQ today are as young as the companies that entered at the close of the 19<sup>th</sup> century. They reason that the electricity era and the information era have much in common -as firms enter the market younger, is because the technologies they bring are too productive to be kept out of the market place too long. Neuer Markt firms in this study took an average of 2.94 years to initial public offering from date of incorporation. However the sample is highly skewed with about 80% of the firms less than 2 years of age, 10% being older than 10 years, and 10% somewhere in between.<sup>6</sup> Further, since the Neuer Markt was not formally introduced until March 1997, there is a bias towards younger firms in the sample.<sup>7</sup> In any event, since 1998 the Neuer Markt firms are indeed relatively young, which is broadly consistent with the notion that the firms on the Neuer Markt may have gone public quickly because the technologies they bring are too productive to be kept out of the market place.

### **III The Neuer Markt, the Data and Measurement Issues**

#### ***The Neuer Markt***

The Neuer Markt was introduced by the Deutsche Bourse on March 10, 1997 and quickly grew from 2 to 343 firms. Since about mid 2000 market forces have steadily inched the Neuer Markt downward leaving the July 2000 index at nearly the opening value of 1000 points -far from the maximum value of 8559.32 points reached on March 10, 2000.<sup>8</sup>

Admission and reporting requirements for Neuer Markt listed firms are more stringent than the rules for the first -Amtlicher Handel and second -Geregelter market segments of the Frankfurt exchange. Firms generally use the International Accounting Standards (IAS) or the US-GAAP reporting standards, but some have made use of a short-term exemption period during which they may follow reporting requirements from the Handelsgesetzbuch (HGB) or German Commercial Code. And while the rules of the Neuer Markt are also more stringent than those of most exchanges in Europe, they remain both more relaxed,

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<sup>6</sup> According to Martin (2001), the average age of Neuer Markt firms in 1998 was 19 years, whereas after then the average age of firms plummeted. In comparison between 1910-1980 most US firms in the Jovanovic and Rousseau (2001) study took between from 10-60 years to initial public offering.

<sup>7</sup> It is possible that some of these firms are also listed on other stock exchanges.

<sup>8</sup> During from March 2000 to July 2001 the market capitalization also went from 234 to 58 billion euros.

and less frequently enforced by the Bundesausichtsamt fuer den Wertpapierhandel (BAWe) than Security and Exchange Commission (SEC) equivalents.<sup>9</sup>

### ***The Sample Data***

The firm level data for the new economy firms came from three sources, the Hoppenstedt database, Deutsche Bundesbank data sources, and publicly available data from the web which in total comprise 820 observations, but not a balanced panel. In Appendix I have listed as of June 2001 the 341 Neuer Markt firms used, as well as their initial public offering dates, and their industry groupings. Exact number of firms used in calculating summary statistics and regressions varied somewhat based on data availability for variables used in that year. 45 of the firms, or over 13% are not German, but firms that originate from Austria, Britain, France, Israel, Ireland, Luxembourg, the Netherlands, Switzerland, and the US.

The firm level data for the old economy firms was taken from the Bonn database. The sample has 295 German firms over the sample period 1970-1985. The Bonn database was constructed from annual business reports of firms, the Handbuch Der\_Aktiengesellschaften, and the Statistisches Jahrbuch. See Chirinko and Elston (1996) for further details on the database.

All firms in this study are listed firms because a) the Neuer Markt is the focus of this study and b) data availability for old economy firms are best for the listed firms. However it is important to note that there are many non-listed privately funded new economy firms (and old economy firms) in Germany. These are of course beyond the scope of this study because of the lack of publicly available data on them.

### ***Measurement Issues***

Sample selection issues can be a problem if the data sample consists only of the firm survivors. An examination of the data sample revealed that up until May 2001 there were no firm deaths, and therefore there should be no bias in estimates due to entry and exit of

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<sup>9</sup> For example in the first six months of 2000, the BAWe fined 44 companies for breaching rules and handed 9 suspected cases of insider trading to state prosecutors. Further responses such as changing the maximum penalty from \$9,000 to \$90,000 is still considered inadequate by many, and there is likely to be more activity over the next few years reworking the regulatory framework of the Neuer Markt.

firms during this sample period.<sup>10</sup> Survival analysis on the old economy firms used from the Bonn database also shows no exit bias. In fact there was an unusually high survival rate of 99% for these firms.

The firm's proxy for cash flow was calculated by using the net of tax sales revenue as reported under the HGB accounting rules as a proxy for firm liquidity constraints. Previous studies on investment-liquidity studies, including Bond et al (2002) have found this to be an adequate proxy for measuring liquidity constraints in Germany's old economy.

Net of tax sales revenue is reported on firm balance sheet under HGB accounting rules in thousands of Euro.<sup>11</sup> Heteroscedastic consistent parameter estimates for regressions were obtained using White's (1980) approach, and are reported in Section IV Empirical Results.

### ***Firm Age***

Time to initial public offering was calculated for all firms in the sample to examine the importance of age in initial public offering cohort year. The oldest firm in the study, PSIAG Gesellschaft incorporated in 1979, while the youngest firms in the study are less than one year old. 281 firms were less than 2 years old, while firms two years old or older totaled 60. In unreported correlation estimates of founding year of firm and time to initial public offering reveal a high ( $R^2 = .9866$ ) and negative correlation, indicating that the younger firm's time to initial public offering is faster. This negative correlation can be explained by the fact that the age of the Neuer Markt itself is a relatively small percentage of these firm life spans, but this finding is also broadly consistent with the notion that the information technology firms are brought to market earlier.

Table A1 in reports the correlation matrix for key variables in the estimations. Results reveal that many of the traditional explanatory variables are correlated which may bias coefficient estimates, and therefore we benefit by examining a more parsimonious growth model. Table 1 therefore explores different combinations of explanatory variables in order to examine the implications for interpreting the size-growth relationship.

In Table A2 descriptive statistics on firm size, growth, age, and cash flow in levels by industry groups and firm size are reported. Most firms in our sample had initial public

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<sup>10</sup> According to the Sueddeutsche Zeitung Nr. 153, page 23, July 6, 2001 -there had been 6 firm insolvencies in 2000 after May including: Gigabell, Infomatic, Kabel New Media, Metabox, Micrologica, Refugium, Sunburst, and Teldafax.

<sup>11</sup> When data was reported in DM it was converted to Euro using the fixed exchange rate of 0.5112.

offerings in 1999 (213 firms) and firm growth averaged almost 100 percent over the sample period, during which larger firms grew nearly ten times faster than smaller firms on the average. From an examination of these means it is apparent that industry growth rates and sizes vary widely. For example in terms of employees, Biotechnology (158), Internet (195), and Media and Advertising (161) appear to be relatively smaller firms –an order of magnitude smaller than Financial (1155) and Commercial Services (973) firms.

#### IV Empirical Results

In Table 1 we examine firm growth for various specifications of the model. Regression 1 is Gibrat’s original specification estimating the impact of initial firm size on growth. Regression 2 is based on Evans (1987) specification, and regression 3 lists results for equation 2 of this paper. It is important to note that independent of specification, results reveal that smaller firms grow faster in the Neuer Markt.

**Table 1: Industry Fixed-Effects Model of Growth 1997-2000**

Regression	Size	Size <sup>2</sup>	Age	CF	adj R2
1	-0.1972* (-4.43)	-	-	-	0.2700
2	-0.1333 (-1.110)	-0.0046 (-0.33)	0.2175* (2.06)	-	0.5580
3	-0.0848** (-1.89)	0.0032 (0.47)	0.0354 (0.26)	0.0258** (1.79)	0.6632
4	-0.1392* (-1.96)	0.0067 (0.83)	-	-0.0338** (-1.76)	0.6614
5	-0.0768* (-2.46)	-	-	0.0341* (1.98)	0.6184

Regression 1 is based on Gibrat (1931). Regression 2 is based on Hall (1987) & Evans (1987). N=287. Because of multicollinearity in Regression 3,4, parsimonious models are represented in regressions 5,6. Regressions are corrected for heteroscedasticity and control for industry, year, accounting period effects. t-statistic is reported in parenthesis and \*, \*\* indicates statistical significance at the 5% and 10% level.

From regression 3 it is also interesting to note that the age variable loses its statistical significance when we add cash flow in the model. One interpretation is that it is not firm age, but the fact that older firms have better access to capital as picked up by the cash flow term, that promotes firm growth.

Evaluating the derivative of the change in growth rates for regressions 2-4 at the sample mean, the calculated marginal effects of size on growth for regression2 is  $-0.0006$ , for regression3 is  $-0.0001$  and for regression 4 it is  $-0.0002$ . This means that each additional employee reduces the growth rate on the average about  $3/10000$  when evaluated at the mean. However, because the size-squared term is never significant, and is also positively correlated with other explanatory variables, we may gain accuracy by adopting a more parsimonious model with regression5.

Overall, growth regression estimates indicate that Gibrat's law does not hold well for the data, with or without controlling for cash flow. However when we do control for cash flow, age is no longer significantly and positively related to growth.

Table 2 compares regression results for both the new economy firms, and old economy firms represented by a panel of 300 mostly large German firms from 1970-1985.<sup>12</sup>

### ***What's New About the New Economy?***

Comparing these results with those from Audretsch and Elston (2001) which use 300 German stocks held and mostly manufacturing firms from 1970-1985 we find several differences between the new and old economy firms.<sup>13</sup> In Table 2 larger firms in the old German economy grew faster and liquidity constraints do not appear to be particularly binding –a finding consistent with earlier studies on this time period in Germany including Audretsch and Elston (2001, 2002). When we divide these old economy firms into 2 groups, based on research and development (R&D) intensity, we find that Gibrat's Law holds for the high R&D firms and firm size appears to play no significant role in explaining firm growth.

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<sup>12</sup> For details see Audretsch and Elston (2001).

<sup>13</sup> To improve comparability between samples, regression on Neuer Markt firms used the identical model specification for firm growth as outlined in equation 2 and used by the Audretsch and Elston (2001) study.



Table 2. Old vs New Economy Firm Growth in Germany

	Old Economy			New Economy				
	All Firms	Low R&D Intensity	High R&D Intensity	All Firms	Low R&D Intensity	High R&D Intensity		
Size	0.0782* (2.78)	0.1016* (2.73)	0.0937* (2.97)	0.1312* (3.48)	0.0236** (1.72)	0.2857 (1.62)	0.0173 (0.82)	-0.0848** (-1.89)
Size <sup>2</sup>	-0.004* (-2.31)	-0.0063* (-2.33)	-0.0059* (-2.62)	-0.0094* (-3.17)	-0.0113** (-1.65)	-0.0170 (-1.51)	-0.0067* (-2.67)	0.0032 (0.47)
Age	0.0003 (0.02)	0.0002 (0.01)	-0.0262 (-1.61)	-0.0258 (-1.60)	0.1578* (2.56)	0.1627* (2.60)	0.0146* (2.39)	0.0354 (0.26)
Cash Flow	---	0.00000 (1.00)	---	0.00005** (1.79)	---	0.00002 (0.63)	---	0.0258** (1.79)
Adj. R <sup>2</sup>	0.1912	0.1950	0.2874	.3019	0.2072	0.2139	0.6432	0.6632
F	4.22	3.97	5.24	5.16	1.25	1.16	24.94	18.34
(prob.)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.2827)	(0.0034)	(0.0001)	(0.0001)
N	226	226	168	168	58	58	297	206

Growth is measured as average change in employment. Old Economy estimates from 300 firm sample 1970-1985.

New Economy estimates from 1997-2000 for 300 firm sample. All regressions use industry, year, and accounting period dummies.

Numbers in parenthesis are t-values, \* =5% and \*\* =10% statistical significance.

Comparing estimates of the new economy, with a) old economy firms in general and b) results for the subset of high R&D firms -which presumably are more similar to our new economy firms, we find some differences.

For example, we find that Gibrat's Law does not hold in general for our new economy firms—unless we control for liquidity constraints. In this case we find that smaller firms grow faster in the new economy and that liquidity constraints are binding, which is not characteristic of our old economy firms. In fact in the old economy, including for high R&D firm subsets, cash flow fails to be a significant indicator of firm growth. So another thing that is new about the new economy is that when we control for cash flow we no longer see older firms growing faster. Whereas old economy high R&D firms grew faster whether we controlled for liquidity constraints or not. The fact that the impact of firm age depends on whether one controlled for firm liquidity also indicates there is a methodological contribution to the partitioning of the size effect.

These results are important to the growth literature because, they suggest that controlling for the impact of firm liquidity constraints makes an important difference in how we are able to measure and interpret the size-growth relationship.

Focussing on policy implications, if we believe that Neuer Markt firms embody new information technologies, not a far fetched notion, then this may signal a fundamental shift not only in the transmission of innovation, but also the size-growth relationship in Germany. That is to say according to stylised facts as set out in Audretsch and Weigand (1999), prior to the 1990's, much of the technical innovation in Germany took place in larger firms. What this study suggests is that today it is not just large, but also smaller technology firms (mean size 313 employees) growing faster and quickly bringing their technologies to market. Although the initial impact appears to be positive for small high technology firms, from a policy perspective it is too early to tell what the long run contributions of the Neuer Markt may be to innovation or employment association with those firms. Recent developments suggest some caution for the future.

The second issue, which this study addresses, is the degree to which liquidity constraints may be linked to firm growth for these firms. If policy makers viewed the introduction of the Neuer Markt as a capital market experiment to channel resources to growing smaller innovative firms with rapid market entries, then the results of this study would support the conclusion that smaller technology firms are growing faster, indicating some clear evidence of the success of the Neuer Markt as a conduit of investment funds to high growth firms in the new economy. Although it is difficult to assess how they might have fared in the absence of the Neuer Markt, or indeed, whether they would have existed at all. Further

studies are indicated in order to determine to what degree being listed on the Neuer Markt has alleviated liquidity constraints, and the extent to which firm capital structure in general impacts growth of these young firms.<sup>14</sup>

## **V Summary and Conclusions**

These findings indicate that there does in fact seem to be a new proportional relationship between firm size and growth in Germany. In the old economy, larger firms grew faster, except for in the high R&D sectors where Gibrat's Law held. Whereas in the new economy, there is a consistency in results which indicate smaller firms grew faster than larger ones.

Further, by controlling for liquidity constraints in the model, it is apparent that firm age becomes less important in explaining growth -indicating that perhaps it is not firm age, but better access to capital and capital markets that lead older firms to higher levels of growth. Once firm liquidity is controlled for in the model, we find evidence that smaller firms grow faster -and that is new for Germany.

This study suggests the possibility that sometime in the 1990s Germany's economic landscape may have changed to one in which fast growing small technology firms established a role as transmitters of innovation to the marketplace, formerly a role that the largest R&D intensive firms dominated.<sup>15</sup>

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<sup>14</sup> Future studies on hazard and survival rates of Neuer Markt firms are justified to clarify issues as on how firm liquidity may effect firm growth and survival over time, in particular during the recession of 2001-2002.

<sup>15</sup> This conclusion becomes particularly strong to the degree that smaller high growth technology were actually started as a result of the funding opportunities presented by the Neuer Markt, rather than the case where existing firms grew faster.

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**Table A1: Correlations of Key Variables**

	Growth	Size <sub>t-1</sub>	Size <sup>2</sup> <sub>t-1</sub>	Revenue <sub>t-1</sub>	Age
Growth	1.0000				
Size <sub>t-1</sub>	-0.3361 (0.0001)	1.0000			
Size <sup>2</sup> <sub>t-1</sub>	-0.3219 (0.0001)	0.9802 (0.0001)	1.0000		
Revenue <sub>t-1</sub>	-0.1581 (0.0640)	0.4096 (0.0001)	0.2983 (0.0004)	1.0000	
Age	-0.0574 (-0.3261)	0.4414 (0.0001)	0.4634 (0.0001)	0.3013 (0.0001)	1.0000

All variables are in natural logs. Size is measured by number of employees, growth is measured by changes in size averaged over the sample period. CF is average firm cash flow and age is 2001 minus IPO date.

**Table A2: Mean Firm Size, Growth, Liquidity, and Age 1997-2000**

Industry / Size	Employees	Firm Growth	Net Revenue (1000's DM)	Firm Age	Obs(max)
1 Biotechnology	158.10 (240.41)	59.13 (76.1)	31725 (45936)	2.38 (0.74)	21
2 Financial Services	1155.00 (1417.81)	264.50 (343.88)	39086 (.)	2.75 (0.50)	5
3 Commercial Services	973.11 (822.53)	364.43 (479.92)	266826 (246757)	4.14 (1.7)	23
4 Internet	194.92 (367.67)	100.69 (153.77)	32939 (50997)	2.63 (0.68)	72
5 Software	194.92 (367.67)	100.69 (153.77)	131594 (248657)	2.63 (0.68)	49
6 Media and Advertising	160.98 (314.67)	34.56 (64.82)	46755 (62552)	2.78 (0.84)	46
7 Healthcare	619.08 (1232.98)	63.40 (157.04)	63297 (101072)	2.92 (1.04)	13
8 Data Processing	253.09 (273.48)	65.56 (211.33)	23159 (26178)	2.97 (0.84)	58
9 Electronics	299.66 (361.27)	47.57 (85.85)	103285 (128509)	2.94 (0.89)	58
10 Telecommunications	402.59 (480.07)	142.15 (330.57)	47738.11 (37429)	3.74 (2.47)	27
Large	871.88 (707.39)	282.92 (331)	150770 (163241)	3.60 (1.3)	106
Small	99.27 (76.64)	29.24 (78.73)	57303 (118674)	2.72 (0.98)	298
Total All Firms	313.66 (512)	100.64 (219.27)	73310 (118674)	2.94 (1.13)	820
Minimum	2.00	-957.00	0.629	1.00	836
Maxmum	3587.00	1679.00	979824	10.00	340

All data for means is in levels. Standard deviation is in parenthesis.

Number of employees is only available for 304 observations, therefore firm Size also.

Small firms are those with less than 313 employees (the sample mean), Large have 313 or more.

Growth is measured as level differences in number of employees ( $e_t - e_{t-1}$ ). Age is 2001- IPO date.

The net of tax sales revenue is used as a proxy for firm liquidity in the rest of the tables.



## Appendix

### List of Neuer Markt Firms as of May 2001

Firm name	IPO date	Index	Industry group	Industry subgroup
3U TELEKOMMUNIKATIONAG	25.11.1999	10	Telecommunications	Telecommunications
4MBO INTERNATLELECTRONICAG	28.8.2000	9	Electronics	Distribution/Wholesale
AAPI IMPLANTATE	10.5.1999	7	Healthcare	Healthcare-Products
ABITAG	3.2.2000	4	Internet	Software
ACGAG	1.7.1999	9	Electronics	Electronics
AC SERVICEAG	30.11.1998	5	Software	Software
ADCON TELEMETRYAG	28.7.1999	9	Electronics	Electronics
ADLINKIN	.	4	Internet	.
ADORIAG	10.5.2000	4	Internet	Internet
ADPEPPER MEDIUMV	9.10.2000	4	Internet	Internet
ADPHOS ADVANCED PHOTONICS	31.7.2000	9	Electronics	Machinery-Diversified
ADSSYSTEMSAG	17.11.1999	9	Electronics	Telecommunications
ADVAAG OPTICAL NETWORKING	29.3.1999	9	Electronics	Telecommunications
ADVANCED	.	6	Media and Advertising	.
ADVANCED	.	9	Electronics	.
AECON.V.	25.7.2000	9	Electronics	Electronics
AIXTRON	6.11.1997	9	Electronics	Semiconductors
ALLGEIER COMPUTERAG	11.7.2000	5	Software	Software
ALPHA FORMAG	28.6.2000	3	Commercial Services	Commercial Services
AMATECHAG	13.6.2000	9	Electronics	Electronics
ANALYTIK JENAAG	3.7.2000	9	Electronics	Biotechnology
ANTWERPESAG	17.4.2000	4	Internet	Internet
ARBOMEDIA.NETAG	9.5.2000	6	Media and Advertising	Advertising
ARTICON-INTEGRALISAG	28.10.1998	9	Electronics	Computers
ARTNET.COMAG	17.5.1999	4	Internet	Internet
ARTSTORAG	11.7.2000	5	Software	Computers
ARXES INFORMATION DESIGNAG	25.1.1999	5	Software	Computers
ASCLEPION-MEDITECAG	22.3.2000	7	Healthcare	Healthcare-Products
ATOSS SOFTWAREAG	21.3.2000	8	Data Processing	Software
AUGUSTE TECHNOLOGIEAG	5.5.1998	9	Electronics	Miscellaneous Manufactur
AUSTRIATECHNOLOGIE&SYSTEM	16.7.1999	9	Electronics	Electronics
B.I.S. BOERSEN INFORMATION DIE	14.6.1999	8	Data Processing	Media
BAEURERAG	2.12.1999	8	Data Processing	Software
BALDAAG	23.11.1999	9	Electronics	Miscellaneous Manufactur
BASLERAG	23.3.1999	9	Electronics	Machinery-Diversified
BBBIOTECHAG-GERMCTF	.	1	Biotechnology	Closed-end Funds
BBMEDTEC	.	7	Healthcare	.
BECHTLEAG	30.3.2000	5	Software	Retail
BEKOHOLDINGAG	14.6.1999	5	Software	Software
BERTRANDTAG	1.10.1996	3	Commercial Services	Commercial Services
BETASYSTEMS SOFTWAREAG	30.6.1997	8	Data Processing	Software
BINTECCOMMUNICATIONS	10.3.1999	10	Telecommunications	Telecommunications
BIODATA INFORMATION TECHAG	22.2.2000	9	Electronics	Computers
BIOLITECAG	15.11.2000	7	Healthcare	Healthcare-Products
BIOTISSUE TECHNOLOGIESAG	1.12.2000	1	Biotechnology	Biotechnology

BIPOP-CARIESPA	.	2	Financial Ser	.
BKNINTERNATIONALAG	9.3.2000	6	Media and Advertising	Media
BLUECNEWECONOMYCONSULT	24.8.2000	4	Internet	Internet
BOVAG	21.6.2000	5	Software	Software
BRAINFORCESOFTWAREAG	10.6.1999	5	Software	Software
BRAININTERNATIONAL	10.3.1999	8	Data Processing	Software
BRAINPOOLTVAG	23.11.1999	6	Media and Advertising	Media
BRAINPOWERNV	21.9.2000	8	Data Processing	Software
BROADVISIONINC	.	4	Internet	Internet
BROKATAG	17.9.1998	4	Internet	Internet
BUCH.DEINTERNETSTORESAG	8.11.1999	4	Internet	Internet
CAAAG	21.7.2000	8	Data Processing	Software
CAATOOSEEAG	20.9.2000	5	Software	Software
CAMELOTAG	30.10.2000	10	Telecommunications	Telecommunications
CANCOMITSYSTEMEAG	16.9.1999	5	Software	Computers
CARRIER1INTLSA	24.2.2000	10	Telecommunications	Telecommunications
CDVSOFTWAREENTERTAINMENT	17.4.2000	8	Data Processing	Software
CECOMPUTEREQUIPMENT	27.4.1998	8	Data Processing	Software
CECONSUMERELECTRONIC	31.12.1998	9	Electronics	Semiconductors
CENITAG	8.12.1998	5	Software	Software
CENTROTECAG	.	3	Commercial Services	Chemicals
CEOTRONICSAG	9.11.1998	9	Electronics	Telecommunications
CINEMEDIAFILMAG	3.2.1999	6	Media and Advertising	Retail
CO.DONAG	14.2.2001	1	Biotechnology	Biotechnology
COMDIRECTBANKAG	5.6.2000	2	Financial Ser	Internet
COMPUTECMEDIAAG	30.11.1998	6	Media and Advertising	Media
COMPUTERLINKSAG	7.7.1999	5	Software	Computers
COMROADAG	.	9	Electronics	Telecommunications
COMTRADEAG	24.11.2000	4	Internet	Computers
CONCEPT!AG	27.3.2000	4	Internet	Computers
CONDATAG	31.12.2000	10	Telecommunications	Software
CONDUITPLC-REGSGDR	30.6.2000	10	Telecommunications	Telecommunications
CONSORSDISCOUNT-BROKERAG	26.4.1999	2	Financial Ser	DiversifiedFinanServ
CONSTANTINFILMAG	13.9.1999	6	Media and Advertising	Media
CORAGINSURANCETECHNOLOGI	27.7.1998	8	Data Processing	Software
CPUSOFTWAREHOUSEAG	19.4.1999	8	Data Processing	Software
CTSEVENTIM	1.2.2000	6	Media and Advertising	LeisureTime
CURASANAG	20.7.2000	1	Biotechnology	Pharmaceuticals
CYBERNETINTERNETSVCSINTL	.	4	Internet	Internet
CYBIOAG	25.11.1999	1	Biotechnology	Healthcare-Products
CYCOSAG	18.4.2000	10	Telecommunications	Software
D.LOGISTICSAG	28.4.1999	3	Commercial Services	Transportation
D+SONLINEAG	23.5.2000	4	Internet	Internet
DASWERKAG	25.8.1999	6	Media and Advertising	Entertainment
DATADESIGNAG	9.11.1998	4	Internet	Internet
DATASAVEAGINFORMATIONSSYS	14.2.2000	5	Software	Internet
DCIDATABASEFORCOMMERCE	13.3.2000	4	Internet	Internet
DEAGDEUTSCHEENTERTAINMEN	14.9.1998	6	Media and Advertising	LeisureTime
DIALOGSEMICONDUCTORPLC	13.10.1999	9	Electronics	Semiconductors
DICOMGROUPPLC-GERMCERT	28.1.2000	8	Data Processing	Software
DIGITALADVERTISINGAG	29.10.1999	4	Internet	Advertising
DINOENTERTAINMENT	12.10.1999	6	Media and Advertising	Media
DIREKTANLAGEBANKAG	15.11.1999	2	Financial Ser	DiversifiedFinanServ

DRHOENLEAG	24.1.2001	9	Electronics	Electronics
DRILLISCHAG	22.4.1998	10	Telecommunications	Telecommunications
E.MULTIDIGITALEDIENSTEAG	19.7.2000	4	Internet	Internet
EASYSOFTWAREAG	19.4.1999	8	Data Processing	Software
EBOOKERS.COMPLC-SPONSADR	.	4	Internet	Internet
ECKERT&ZIEGLERSTRAHLENUN	25.5.1999	7	Healthcare	Healthcare-Products
EDELMUSICAG	2.9.1998	6	Media and Advertising	HomeFurnishings
EJAYAG	8.8.2000	6	Media and Advertising	Software
ELECTRONICSLINELTD.	.	9	Electronics	Telecommunications
ELMOSSEMICONDUCTORAG	11.10.1999	9	Electronics	Semiconductors
ELSAAG	15.6.1998	9	Electronics	Software
EM.TV&MERCHANDISINGAG	30.11.1997	6	Media and Advertising	Media
EMPRISEMANAGCONSULTAG	16.7.1999	5	Software	Computers
EMSNEWMEDIAAG	21.11.2000	6	Media and Advertising	Media
ENDEMANN!!!INTERNETAG	10.3.1999	4	Internet	Internet
ENERGIEKONTORAG	25.5.2000	9	Electronics	Energy-AlternateSources
EUROFINSSCIENFIC	.	1	Biotechnology	EnvironmentalControl
EUROMEDAG	16.6.1999	7	Healthcare	Healthcare-Services
EUROMICRONAG	29.6.1998	9	Electronics	Electronics
EVOTECBIOSYSTEMSAG	.	1	Biotechnology	CommercialServices
F.A.M.E.FILM&MUSICENTERT	31.8.2000	6	Media and Advertising	Media
FABASOFTAG	1.10.1999	8	Data Processing	Software
FANTASTICCORP-CTFS	28.9.1999	4	Internet	Internet
FEEDBACKAG	28.6.2000	4	Internet	Internet
FJAAG	21.2.2000	8	Data Processing	Software
FLUXX.COMAG	28.9.1999	4	Internet	Internet
FOCUSDIGITALAG	13.7.2000	6	Media and Advertising	Media
FORISAG	19.7.1999	2	Financial Ser	DiversifiedFinanServ
FORTECELEKTRONIKVERTRIEBS	.	9	Electronics	Semiconductors
FORTUNECITY.COMINC	19.3.1999	4	Internet	Internet
FREENET.DEAG	3.12.1999	4	Internet	Internet
FUNKWERKAG	15.11.2000	10	Telecommunications	Electronics
GAPAG	20.9.2000	9	Electronics	Telecommunications
GAUSSINTERPRISEAG	28.10.1999	4	Internet	Internet
GEDYSINTERNETPRODUCTSAG	27.9.1999	4	Internet	Software
GENESCANEUROPEAG	21.7.2000	1	Biotechnology	Healthcare-Services
GENMABA/S-DT.CERTS.(COIS)	18.10.2000	1	Biotechnology	Biotechnology
GERICOMAG	20.11.2000	9	Electronics	Computers
GESELLSCHAFTFUERNETWORKT	6.8.1997	5	Software	CommercialServices
GFTTECHNOLOGIESAG	28.6.1999	4	Internet	Software
GIGABELLAG *	11.8.1999	4	Internet	Internet
GIRINDUSAG	16.5.2000	1	Biotechnology	Biotechnology
GPCBIOTECHAG	31.5.2000	1	Biotechnology	Biotechnology
GRAPHISOFTNV	8.6.1998	8	Data Processing	Software
GRENKELEASINGAG	4.4.2000	3	Commercial Services	DiversifiedFinanServ
GROUPTECHNOLOGIESAG	21.11.2000	8	Data Processing	Internet
H5B5MEDIAAG	21.2.2000	6	Media and Advertising	Media
HAITECAG	14.7.1999	5	Software	Software
HEILERSOFTWAREAG	7.11.2000	4	Internet	Internet
HELKONMEDIAAG	7.10.1999	6	Media and Advertising	Media
HEYDEAGBERATUNGSOFTWARE	14.9.1998	5	Software	Software
HIGHLIGHTCOMMUNICAT-	11.5.1999	6	Media and Advertising	Entertainment
HOEFT&WESSELAG	20.7.1998	9	Electronics	Hand/MachineTools

HUNZINGERINFORMATIONAG	.	3	Commercial Services	Advertising
I:FAOAG	1.3.1999	4	Internet	LeisureTime
IBSAGENGINEERINGCONSULT	21.6.2000	8	Data Processing	Software
I-DMEDIAAG	17.6.1999	4	Internet	Internet
IDSSCHEERAG	11.5.1999	5	Software	CommercialServices
IMINTERNATIONALMEDIAAG	18.5.2000	6	Media and Advertising	Media
INFOGENIEEUROPEAG	25.10.2000	5	Software	CommercialServices
INFOMATECINTEGRATEDINFOSY	3.7.1998	4	Internet	InternetApplicationsSo
INFORBUSINESSSOLUTIONSAG	11.5.1999	8	Data Processing	Software
IN-MOTIONAG	20.6.2000	6	Media and Advertising	Media
INTEGRASA	.	4	Internet	Internet
INTERNETMEDIAHOUSE.COMAG	30.7.1999	4	Internet	Internet
INTERNOLIXAG	27.3.2000	4	Internet	Internet
INTERSHOPCOMMUNICATIONSAG	16.7.1998	4	Internet	Internet
INTERENTAINMENTAG	8.2.1999	6	Media and Advertising	Media
INTRAWAREAG	12.5.2000	8	Data Processing	Software
IPCARCHTECAG	7.3.2000	9	Electronics	Distribution/Wholesale
ISIONINTERNETAG	17.3.2000	4	Internet	Internet
ISRAVISIONAG	20.4.2000	9	Electronics	Electronics
ITELLIGENCEAG	.	5	Software	Software
IVUTRAFFICTECHNOLOGIESAG	7.7.2000	5	Software	Software
IXOSSOFTWAREAG	7.10.1998	8	Data Processing	Software
JACKWHITEPRODUCTIONSAG	13.9.1999	6	Media and Advertising	HomeFurnishings
JETTERAG	19.8.1999	9	Electronics	Electronics
JOBPILOTAG	5.4.2000	4	Internet	CommercialServices
JUMPTTECINDUSTRIELLECOMPUT	26.3.1999	9	Electronics	Semiconductors
KABELNEWMEDIA	15.6.1999	4	Internet	Internet
KINOWELTMEDIENAG*	12.5.1998	6	Media and Advertising	Media
KLEINDIENSTDATENTECHNIK	2.6.1999	8	Data Processing	Software
KONTRONEMBEDDEDCOMPUTER	6.4.2000	9	Electronics	Semiconductors
KRETZTECHNIKAG	27.3.2000	7	Healthcare	Healthcare-Products
LAMBDAPHYSIKAG	21.9.2000	9	Electronics	Electronics
LETSBUYIT.COMNV	21.7.2000	4	Internet	Internet
LINOSAG	4.9.2000	9	Electronics	Electronics
LINTECCOMPUTERAG	7.9.1998	9	Electronics	Computers
LIONBIOSCIENCEAG	11.8.2000	1	Biotechnology	Software
LIPROAG	15.10.1999	8	Data Processing	Software
LOBSTERNETWORKSTORAGEAG	12.5.1998	9	Electronics	Software
LPKFLASER&ELECTRONICS	30.11.1998	9	Electronics	Electronics
LYCOSEUROPEAN.V.	22.3.2000	4	Internet	Internet
M+SELEKTRONIKAG	29.2.2000	5	Software	Computers
MACROPOREINC	10.8.2000	1	Biotechnology	Healthcare-Products
MANAGEMENTDATASOFTWAREE	22.6.1999	8	Data Processing	Software
MANIATECHNOLOGIEAG	26.7.1999	9	Electronics	Semiconductors
MATCHNETPLCSPONSREGSGDR	27.6.2000	6	Media and Advertising	Internet
MAXDATA COMPUTERAG	9.6.1999	9	Electronics	Computers
MBSOFTWAREAG	17.11.1998	8	Data Processing	Software
MEDIA!AG	29.6.2000	6	Media and Advertising	Media
MEDIA[NETCOM]AG	5.7.2000	6	Media and Advertising	Internet
MEDIANTISAG	5.7.1999	4	Internet	Internet
MEDIASCAPECOMMUNICATIONSA	22.5.2000	4	Internet	Internet
MEDIGENEAG	30.6.2000	1	Biotechnology	Biotechnology
MEDIONAG	26.2.1999	9	Electronics	Distribution/Wholesale

MENSCHUNDMASCHINESOFTWA	21.7.1997	8	Data Processing	Software
METABOXAG*	7.7.1999	9	Electronics	Telecommunications
MICROLOGICAAG*	21.9.1998	3	Commercial Services	Software
MICROLOGLOGISTICSAG	28.6.2000	3	Commercial Services	Transportation
MICRONASSEMICONDUCTOR- MISAG	15.7.1999 15.2.2000	9 8	Electronics Data Processing	Semiconductors Software
MMEME,MYSELF&EYEENTERTA	20.11.2000	6	Media and Advertising	Media
MOBILCOMAG	10.3.1997	10	Telecommunications	Telecommunications
MORPHOSYSAG	9.3.1999	1	Biotechnology	Biotechnology
MOSAICSOFTWAREAG	1.7.1999	8	Data Processing	Software
MOUNT10INC	11.2.2000	5	Software	Software
MSHINTERNATIONALSERVICEAG	10.9.1999	.	.	.
MUEHLBAUERHOLDINGAG&CO	10.7.1998	9	Electronics	Machinery-Diversified
MUEHLPRODUCT&SERVICEAG	25.8.1995	3	Commercial Services	BuildingMaterials
MUSICMUSICMUSICINC	1.10.1999	4	Internet	Internet
MWG-BIOTECHAG	7.5.1999	1	Biotechnology	Biotechnology
NEMETSCHEKAG	10.3.1999	8	Data Processing	Software
NETAGINFRASTRUCTURESOFT	17.3.2000	4	Internet	Internet
NETLIFEAG	1.6.1999	4	Internet	Computers
NEUESENTIMENTALFILMAG	21.11.2000	6	Media and Advertising	Advertising
NEXUSAG	24.7.2000	5	Software	Software
NORCOMINFORMATIONTECHNOL	30.9.1999	8	Data Processing	Software
NOVASOFTAG	15.11.1999	5	Software	CommercialServices
NOVEMBERAG	10.4.2000	1	Biotechnology	Pharmaceuticals
NSESOFTWAREAG	20.4.1999	8	Data Processing	Software
ODEONFILMAG	12.4.1999	6	Media and Advertising	Entertainment
ONVISTAAG	28.2.2000	4	Internet	Internet
OPENSHOPHOLDINGAG	21.3.2000	4	Internet	Internet
ORADHI-TECHSYSTEMSLTD	16.11.1999	8	Data Processing	Computers
ORBISAG	25.9.2000	5	Software	Software
OTIONTRACKINNOVATIONSLTD	31.8.1999	9	Electronics	Electronics
P&IPERSONAL&INFORMATIKAG	7.7.1999	8	Data Processing	Software
P&TTECHNOLOGYAG	28.11.2000	9	Electronics	ElectricalCompo&Equip
PANDATELAG	2.11.1999	10	Telecommunications	Telecommunications
PANKLRACINGSYSTEMSAG	.	9	Electronics	AutoParts&Equipment
PARAGONAG	29.11.2000	9	Electronics	Electronics
PARSYTECAG	16.6.1999	8	Data Processing	Software
PC-SPEZIALISTFRANCHISEAG	25.8.1999	9	Electronics	Retail
PC-WAREAG	5.5.2000	8	Data Processing	Computers
PFEIFFERVACUUMTECHNOLOGY	16.7.1996	3	Commercial Services	Machinery-Diversified
PGAMADVANCEDTECHNOLOGIES	14.9.2000	5	Software	CommercialServices
PHENOMEDIAAG	22.11.1999	6	Media and Advertising	Software
PIRONETAG	22.2.2000	8	Data Processing	Internet
PIXELNETAG	21.6.2000	4	Internet	Retail
PIXELPARKAG	4.10.1999	4	Internet	Internet
PLAMBECKNEUEENERGIEN-REG	15.12.1998	9	Electronics	Energy-AlternateSources
PLASMASELECTAG	1.3.2000	1	Biotechnology	Healthcare-Products
PLAUTAG	9.11.1999	3	Commercial Services	CommercialServices
PLENUMAG	3.8.1998	5	Software	Computers
POETHOLDINGSINC	16.11.1999	8	Data Processing	Software
POPNETINTERNETAG	2.2.2000	4	Internet	Computers
PRIMACOMAG	22.2.1999	10	Telecommunications	Media
PROACTAAG	7.6.1999	5	Software	Software

PRODVSOFTWAREAG	22.3.2000	8	Data Processing	Software
PROUTAG	27.4.1999	8	Data Processing	CommercialServices
PSBAGFUERPROGRAMMIERUNG	27.7.1999	5	Software	Computers
PSIAGGESELLSCHAFT	31.8.1998	8	Data Processing	Software
QIAGEN.N.V.	.	1	Biotechnology	Biotechnology
QSCOMMUNICATIONSAG	19.4.2000	4	Internet	Internet
REALTECHAG	26.4.1999	5	Software	CommercialServices
REFUGIUMHOLDINGAG*	25.8.1997	7	Healthcare	Healthcare-Services
RHEINBIOTECHN.V.	21.4.1999	1	Biotechnology	Biotechnology
RICARDO.DEAG	21.7.1999	.	.	.
ROESCHMEDIZINTECHNIKAG	24.2.2000	7	Healthcare	Healthcare-Products
RTRIASOFTWAREAG	10.5.1999	.	.	.
RTVFAMILYENTERTAINMENT	8.6.1999	6	Media and Advertising	Entertainment
RUECKERAG	15.5.2000	3	Commercial Services	Software
SACHSENRINGAUTOMOBILTEC	2.10.1997	3	Commercial Services	AutoParts&Equipment
SALTUSTECHNOLOGYAG	14.7.1997	3	Commercial Services	AutoParts&Equipment
SANOCHEMIAPHARMAZEUTIKAAG	12.5.1999	1	Biotechnology	Pharmaceuticals
SAPSYSTEMSINTEGRATIONAG	13.9.2000	5	Software	Computers
SCMMICROSYSTEMSINC	.	9	Electronics	Computers
SECUNETSECURITYAG	9.11.1999	5	Software	Computers
SENATORENTERTAINMENTAG	29.1.1999	6	Media and Advertising	Media
SERSYSTEMEAG	14.7.1997	8	Data Processing	Software
SHSINFORMATIONSSYSTEMEAG	19.5.1999	5	Software	Computers
SILICONSENSORINTLAG	15.7.1999	9	Electronics	Electronics
SINGULUSTECHNOLOGIES	25.11.1997	9	Electronics	Machinery-Diversified
SINNERSCHRADERAG	2.11.1999	4	Internet	Internet
SOFTINGAG	16.5.2000	9	Electronics	Electronics
SOFTLINEAG	14.2.2000	8	Data Processing	Computers
SOFTMATICAG	1.6.1999	8	Data Processing	Software
SOFTMSOFTWAREUNDBERATUN	21.7.1998	8	Data Processing	.
SPLENDIDMEDIENAG	24.9.1999	6	Media and Advertising	Media
STEAGHAMATECHAG	12.5.1999	9	Electronics	Machinery-Diversified
SUESSMICROTEC	18.5.1999	9	Electronics	Semiconductors
SUNBURSTMERCHANDISINGAG*	27.9.1999	6	Media and Advertising	CommercialServices
SUNWAYSAG	9.2.2001	9	Electronics	ElectricalCompo&Equip
SWING!ENTERTAINMENTMEDIA	2.2.2000	6	Media and Advertising	Software
SYSKOPLANAG	2.11.2000	5	Software	Software
SYSTEMATICSAG	27.9.1999	5	Software	Computers
SYZYGYAG	6.10.2000	4	Internet	Internet
SZTESTSYSTEMEAG	2.6.1999	9	Electronics	Electronics
TDSINFORMATIONSTECHNOLOGI	26.6.1998	5	Software	Computers
TEAMCOMMUNICATIONSGROUP	.	6	Media and Advertising	Media
TEAMWORKINFMANAG*	14.7.1999	4	Internet	Software
TECHNOTRANS	10.3.1998	9	Electronics	Machinery-Diversified
TELDAFAXAG*	.	10	Telecommunications	Telecommunications
TELEATLASBV	26.5.2000	9	Electronics	Software
TELEGATEAG	22.4.1999	10	Telecommunications	Telecommunications
TELEPLANINTERNATIONALNV	23.11.1998	3	Commercial Services	Computers
TELESAG	30.6.1998	10	Telecommunications	Telecommunications
TELESENSKSLAG	21.3.2000	10	Telecommunications	Software
TEPLAAG	21.6.1999	9	Electronics	Semiconductors
THIELLOGISTIKAG	20.3.2000	3	Commercial Services	Software
TIPTELAG	1.7.1992	10	Telecommunications	Telecommunications

TISCONAGINFOSYSTEMS	14.10.1999	5	Software	Software
TOMORROWINTERNETAG	30.11.1999	4	Internet	Media
T-ONLINEINTERNATIONALAG	17.4.2000	4	Internet	Internet
TRANSTECAG	3.4.1998	9	Electronics	Computers
TRAVEL24.COM	15.3.2000	4	Internet	Internet
TRIASOFTWAREAG	10.5.1999	5	Software	Software
TRINTECHGROUP-ADR	24.9.1999	4	Internet	Software
TRIOUSAG	9.3.2000	10	Telecommunications	Telecommunications
TTLINFORMATIONTECHNOLOGY	12.7.1999	5	Software	Computers
TV-LOONLANDAG	22.3.2000	6	Media and Advertising	Media
UMSUNITEDMEDICALSYSINTL	17.7.2000	7	Healthcare	Healthcare-Services
UMWELTKONTORRENEWABLEEN	5.7.2000	9	Electronics	Energy-AlternateSources
UNITEDINTERNETAG-REGSHARE	23.3.1998	4	Internet	Advertising
UNITEDLABELSAG	10.5.2000	6	Media and Advertising	CommercialServices
UNITEDVISIONSENTERTAINMENT	20.6.2000	6	Media and Advertising	Media
UPDATE.COMSOFTWARE	11.4.2000	8	Data Processing	Internet
USUSOFTWAREHAUSUNTERNEH	4.7.2000	8	Data Processing	Software
UTIMACOSAFEWAREAG	16.2.1999	8	Data Processing	Computers
VALORCOMPUTERIZEDSYSTEMS	15.5.2000	8	Data Processing	Software
VARETISAG	7.2.2000	10	Telecommunications	Telecommunications
VECTRONSYSTEMSAG	16.6.1999	9	Electronics	Computers
VI[Z]RT	8.11.1999	9	Electronics	Electronics
VISIONIXLIMITED	1.2.2000	6	Media and Advertising	Media
VIVAMEDIAAG	19.7.2000	5	Software	Software
W.E.T.AUTOMOTIVESYSTEMSAG	28.4.1998	3	Commercial Services	AutoParts&Equipment
WAPMESYSTEMSAG	5.7.2000	4	Internet	Internet
WAVELIGHTLASERTECHNOLOGIE	15.9.1999	7	Healthcare	Healthcare-Products
WEB.DEAG	17.2.2000	4	Internet	Internet
WINTERAG	25.9.2000	9	Electronics	Electronics
WIZCOMTECHNOLOGIESLTD	29.3.1999	9	Electronics	Computers
WWLINTERNETAG	15.7.1999	4	Internet	Internet

Total 343 firms

\*Denotes firm insolvency as of July 11, 2001.

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