RISK DYNAMICS AND STOCK TRADING ACTIVITY AROUND NEW PRODUCT INTRODUCTIONS –

COST OF CAPITAL IMPLICATIONS FROM THE PHARMACEUTICAL INDUSTRY

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ABSTRACT

We analyze the relationship between new product introductions, trading activity, and systematic risk changes. The analysis is placed within a real options framework in which new product introductions are associated with the exercise of a real option. Using a unique hand-collected data set on new drug approvals, we find opposing results to previous work. Trading activities change after new product announcements and stock become more liquid. However, we have no evidence on changes in systematic risk. After adjusting for potential biases caused by increased leverage and frictional trading, estimates for systematic risk are indifferent before and after the new product announcement. Our results have implications for the firm's cost of capital and internal investment decisions. Investors' required return remains unchanged and cost of equity for technological-intensive companies is invariant to new product introductions and the exercise of corresponding real options.

KEYWORDS

Product Innovations; Wealth Effects; Trading Activity; Liquidity; Systematic Risk; Real Options

JEL CLASSIFICATION

G32; G14; M21

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I. INTRODUCTION

Product innovation is a necessary requirement for companies in today's research- and knowledge-based economy. Several studies report positive wealth effects for new product introductions (Chaney et al. (1991), Bosch et al. (1994), Sharma and Lacey (2004), Sarkar and De Jong (2006), Dedman et al. (2008)). However, little evidence is provided on risk dynamics associated with new product innovation although systematic risk changes are of great importance to company managers. Outside investors rely on the systematic risk of a company to derive return requirements as outlined in the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1965). Corporate managers, in turn, rely on the CAPM implications in capital budgeting decisions. The surveys by Bruner et al. (1998) and Harvey and Graham (2001) reveal that the cost of equity estimate based on the CAPM reflects the predominant method in calculating the firm's cost of capital. The authors also find that most firms use the company's overall risk when assessing new projects. Hence, changes in systematic risk are of vital interest to financial practitioners and affect companies' internal hurdle rates to evaluate new investments. Our goal is to analyze whether new product introductions causes changes in systematic risk and therefore influence the firm's capital budgeting and future investment strategy.

We study systematic risk changes of new product introductions within a real options context in which a product introduction is consistent with the exercise of a growth option. The framework is similar to Bernardo et al. (2007). The firm's assets are split in assets-in-place and growth opportunities. Asset betas are partitioned accordingly. Assuming constant systematic risk of assets in place, a change of the overall asset beta is then attributable to new product introduction and the exercise of the corresponding growth option.

A unique hand-collected data set of new drug approvals serves as empirical testing ground. We analyze the entire spectrum of drugs approved by the European Medicine Agency since its initiation in 1995. A final sample of 150 new drug approvals by 65 pharmaceutical companies serves as data basis. Systematic

risk is estimated via a market model approach. We explicitly test for potential biases in estimating systematic risk and employ the procedure introduced by Cohen et al. (1983).

Our results show a significant positive stock price reaction to new product introductions. In addition, we find high abnormal trading activities immediately surrounding the event. The data also provides evidence on long-term, structural changes in trading pattern. Stocks of new product introducing firms become more liquid after the announcement. The absolute and value-weighted daily stock turnover increases significantly after the new product is released. The results on associated risk dynamics are striking. In contrast to the implications modeled by Berk et al. (1999) and Jacquier et al. (2009), we find no evidence on systematic risk changes associated with new product announcements and the exercise of real option. After controlling for potential estimation biases caused by frictional trading and leverage impact (e.g., Hamada (1972), Cohen et al. (1983)), we find no significant changes of systematic risk prior and subsequent to the event.

The findings have important implications for capital budgeting decisions. Evidence suggests that firm risk is invariant to new product introductions. Investors do not adjust their return requirements. Consequently, managers should not mistake a successful new product release with lower cost of capital.

The remainder of this study is organized as follows. In section II, we summarize the literature on new product introductions and associated wealth effects. The risk framework we use is presented as well. Section III introduces the data set employed to test empirically for risk changes of new product introductions. In section IV, we summarize our main empirical results relating to trading activity and systematic risk changes. Section V concludes our paper.

II. THEORETICAL BACKGROUND

REVIEW OF RELATED LITERATURE

Though becoming increasingly important, the field of new product research has been largely unexplored. Historically, empirical studies focused almost exclusively on wealth effects for companies introducing new products (Chaney et al. (1991), Bosch et al. (1994), Sharma and Lacey (2004), Sarkar and De Jong (2006), Dedman et al. (2008)). Employing an event-study context, these studies analyze abnormal stock price reactions to new product introductions. Chaney et al. (1991) analyze new product initiations between 1975 and 1984. The authors report positive announcement effects for launches in the pharmaceutical and chemical industry. Bosch et al. (1994) examine the stock price reaction to 130 FDA drug approval decisions between 1962 and 1989 and find on average a significant positive abnormal return of 1.84 % for the issuing firm. Sharma and Lacey (2004) use an updated data set on 344 FDA drug authorizations. Their analysis reveals a significant positive wealth effect of 1.56%. Sarkar and De Jong (2006) also hark back to the FDA decisions along the drug approval process. The authors report significant abnormal stock returns for each interim decision as well as the final approval. Dedman et al. (2008) study a sample of UK biotechnology and pharmaceutical companies and find positive stock price reactions to marketing authorization decisions, too.

Except for the well documented positive wealth effects, we know little about further dynamics associated with new product introductions. In particular, little evidence has been provided on the impact that product innovations have on corporate risk dynamics and trading behavior. Our study narrows this gap and provides empirical evidence on risk changes and trading patterns surrounding new product initiations

We concentrate explicitly on the changes in systematic risk around the announcement of a new product introduction. From a shareholder's perspective, systematic risk is the only source of concern and determines expected asset returns as outlined in the capital asset pricing model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1965). Systematic risk, measured as the sensitivity of an asset's return to the

market return (denoted as beta), links the corporate viewpoint with the shareholder perspective. The required return for equity investors, in turn, determines the cost of capital for the firm and hence influences corporate investment strategy. Bruner et al. (1998) and Graham and Harvey (2001) report survey results that corporate decision makers use predominantly the CAPM framework to determine the respective cost of capital. The majority of companies also use firm risk rather than project risk in evaluating new investments. Consequently, financial managers should take changes in the firm's systematic risk component into account for capital budgeting decisions. If a product introduction adds marginally to the systematic risk of the firm, then the company's overall cost of capital is to be adjusted.

Several studies analyze different financial variables and their impact on systematic risk (e.g., Beaver et al. 1970), Hamada (1972), Mandelker and Rhee (1984), Ismail and Kim (1989)). However, few empirical studies have addressed the relationship of product innovation and systematic risk so far. Chaney et al. (1991) calculate average equity betas for their sample of 231 firms introducing 1,101 new products between 1975 and 1984. They find an average beta of 1.182 and interpret the results as evidence of greater risk than the average market. Their study is limited by the static view employed. An explicit beta change by comparing systematic risk before and after the product introduction is omitted. Devinney (1992) contrasts explicitly the equity betas around 1,677 new product releases between 1984 and 1988. He reports a small but significant systematic risk decrease from a mean pre-announcement beta of 1.274 to an average post-announcement beta of 1.235. However, the results are possibly biased by not controlling for any confounding effects on the beta estimation such as a change in leverage (e.g., Hamada (1972)) or non-synchronous trading (e.g., Scholes and Williams (1977), Dimson (1979), Cohen et al. (1983)). Denis and Kadlec (1994) show in their study that estimation biases can alter results fundamentally. We take these suggestions on estimation biases into account when assessing the relationship of new product innovation and company systematic risk. Thereby, our study provides new and robust evidence on the relationship of product innovation and systematic risk changes.

RISK FRAMEWORK

To estimate the impact of new product introductions on the firm's systematic risk and its cost of capital, we apply an options-based framework in which the new product release reflects the exercise of a growth option. For our analysis, we distinguish between two sources of company value as reported in equation 1 (e.g., Myers (1977), Miles (1986), Chung and Charoewong (1991), Jägle (1999)): A proportion steaming from assets already in place (e.g. present value of cash flows generated by existing assets) and the value of future growth opportunities (e.g., potential cash flows from new products or projects). This entanglement of sources for company value mirrors adequately the outstanding growth prospects of research-and technology-intensive firms engaged in new product development activities. Shareholder value is created by an existing stock of assets that generates current and future cash flows. In addition, the firm realizes growth opportunities by developing a stock of knowledge and new product candidates. Such in-tangible investments provide the firm the choice to abandon, delay, or exercise pre-built options in the future. Accordingly, new product development represents an investment in potential growth options for the firm. The future market introduction of the product reflects the exercise of the option associated with an increase in future cash flows. Additional cash flows make the firm more valuable to investors. Hence, positive stock price reactions to new product introductions are to be expected.

(1) Market Value = Futue Value of Existing Assets + Value of Future Growth Opportunities.

For the risk analysis, we use a framework similar to Bernardo et al. (2007) on the relationship of growth options and asset beta. It allows us to measure the marginal impact of a new product release on the firm's systematic risk and cost of capital. From the above separation of the firm's market value into a present and future component, it follows that a firm's asset beta is split accordingly in a weighted average of assets already in place and the beta of growth opportunities:

(2)
$$\beta_{t,i}^{A} = \frac{AP_{t,i}}{A_{t,i}}\beta_{t,i}^{AP} + \frac{GO_{t,i}}{A_{t,i}}\beta_{t,i}^{GO}.$$

Where $\beta_{t,i}^{A}$ denotes the asset beta of firm *i* at time *t*. $\beta_{t,i}^{AP}$ refers to the beta of assets already in place, $\beta_{t,i}^{GO}$ reflects the beta of the firm's growth opportunities, *AP* and *GO* indicate the present value of the firm's current assets in place and future growth opportunities with *AP* and *GO* adding up to the firm's total assets *A*.

In a market value balance sheet context, $\beta_{t,i}^{A}$ can also be regarded as the firm's unlevered equity beta. Assuming a beta of zero for the firm's outstanding debt as in Hamada (1972), Denis and Kadlec (1994), Lewis et al. (2002) and desisting from tax issues, we can rewrite $\beta_{t,i}^{A}$ as:

(3)
$$\beta_{t,i}^{A} = \left(\frac{E_{t,i}}{D_{t,i} + E_{t,i}}\right)\beta_{t,i}^{E}.$$

Where $\beta_{t,i}^{E}$ refers to the company's equity beta, $E_{t,i}$ represents the market value of equity of firm *i* at time *t* and $D_{t,i}$ denotes the market value of debt accordingly.

It seems reasonable to assume, that the systematic risk component of a firm's assets in place is unaffected by risk changes associated with its existing growth options. That is, we assume that no structural relationship exists between cash flows associated with assets in place and cash flows associated with growth opportunities. If a firm chooses to exercise existing options, the risk of cash flows associated with these growth opportunities $GO_{t,i}$ could change. However, an immediate effect on the risk of cash flows generated by assets already in place $AP_{t,i}$ is unlikely. In summary, we assume throughout our analysis that the beta of the firm's assets in place $\beta_{t,i}^{A}$ remain constant and invariant to changes in its growth options beta $\beta_{t,i}^{GO}$. We also presume the relative weights of assets in place and growth options to remain constant.¹

The outlined framework allows us to estimate the firm's asset beta before and after the new product introduction by unlevering its corresponding equity beta. The latter can be derived via an one-factor market model estimation. A change in the firm's asset beta would then be attributable to the exercise of a real option and a corresponding change in the risk of the firm's growth options.

Theory provides no clear prediction about the impact of option exercise on the firm's systematic risk and its cost of capital. Berk et al. (1999) develop a model in which the exercise of growth options changes a firm's systematic risk exposure. Jacquier et al. (2009) derive similar conclusions but relate the change to various other company variables. Mc Alister et al. (2007) argue that R&D efforts create intangible assets that, in fact, insulate the firm from stock market changes and therefore lower systematic risk exposure. Our study provides empirical evidence on this large unexplored issue. We examine explicitly the effects of new product introductions on company systematic risk while controlling for confounding effects. The results allow us to draw conclusions on the relationship between new product initiations and changes in the firm's cost of capital.

¹ This assumption is verified empirically by comparing the relative weights of growth options before and after the new product introduction. We proxy the firm's growth options by the company's market-to-book ratio of equity capital as in Fama and French (1992) and Chan et al. (2001). We find no significant changes in the level of growth options before and after the new product release.

III. SAMPLE SELECTION AND DESCRIPTION

For our empirical analysis of systematic risk changes around new product introductions we employ a unique data set on new drug approvals by the European Medicines Agency (EMEA). Product innovation in the pharmaceutical industry allow for an unbiased study of introductory effects given the highly regulated and clear-cut drug development procedures. We concentrate on new drug approvals as a form of new product introductions and use both terminologies interchangeably. Since 1995, drug developers can apply for European-wide approval at the EMEA. The centralized approval procedure is a voluntary alternative to multiple approval procedures in each member state and compulsory for all biotechnology products in the European Union (see, e.g., Garattini and Bertele (2004) for more information on the EU centralized drug approval procedure).

We hand-collected all public assessment reports on the entire universe of drugs filled for EMEA approval since 1995.² The event of interest is defined as the date when the Committee for Proprietary Medicinal Products (CPMP) which reviews the application documents issued a positive opinion on the drug filled for approval. Although the CPMP decision must officially be approved by the European Commission (EC), the EC decision usually represents a pro-forma step and a positive CPMP vote can typically be regarded as a quasi-approval. Company data for the applying firms is collected via Thomson Datastream and Worldscope.

We examined 447 drug assessment reports for various criteria. Several observations had to be excluded for comparability. First, we eliminate all drug approvals for which the sponsor either was not a listed company or could not doubtlessly identified. Second, companies with missing time-series data in Datastream were deleted. Next, all drug approvals for which the initial product has been given marketing approval elsewhere were eliminated. This ensures that our sample solely consists of true product newcomers. To reduce potential biases of clustered events, we exclude all new drug approvals when the issuing

² Public assessment reports are retrieved at <u>http://www.emea.europa.eu/htms/human/epar/a.htm</u>. Missing data was kindly provided by EMEA upon the author's request.

firm had additional drug approvals within a 250 day period. Finally, to prevent our results from being distorted by any illiquidity bias, we employ the procedure developed by Amihud (2002). A 250–trading day period is chosen to estimate the illiquidity measures. We exclude the most extreme 1 % of our events as well as events with missing data on trading volume. The filtering criteria leave us with a final sample of 150 drug approvals by 65 pharmaceutical firms.

Descriptive statistics on our event sample are provided in table 1 - 3. Table 1 reports the event distribu-

tion over time. Events are spread evenly across calendar time. We do not observe any clustering of ap-

proval events in time. No more than 13.33% of our event universe is attributable to any single year.

Table 1

Event Distribution over Time

This table reports the distribution of events across calendar time. It includes 150 drug approval decisions issued by the EMEA within the observation period between 1995 and 2009. Absolute *Number of Events per Year* as well as *Percentage of Total Events per Year* are included. The Cumulative Percentage of Events per Year are also posted.

Calendar Year	1995	1996	1997	1998	1999	2000	2001	2002
Number of	0	E	E	0	E	20	o	11
Events per Year	0	5	5	9	5	20	0	14
Percentage of	0.000/	2 220/	2 220/	6.00%	2 2 2 0/	12 220/	F 220/	0 2 2 0/
Total Events per Year	0.00%	5.55%	5.55%	0.00%	5.55%	13.33%	5.55%	9.55%
Cumulative Percentage	0.000/	2 220/	6 670/	12 (70/	16.000/	20 220/	24 670/	44.000/
of Events per Year	0.00%	3.33%	0.07%	12.07%	16.00%	29.33%	34.07%	44.00%
Calendar Year	2003	2004	2005	2006	2007	2008	2009	Totals
Number of	0	15	0	17	20	14	0	150
Events per Year	9	15	9	17	20	14	0	150
Percentage of	C 00%	10.00%	6.00%	11 220/	12 220/	0.220/	0.00%	100.000/
Total Events per Year	0.00%	10.00%	0.00%	11.55%	15.55%	9.55%	0.00%	100.00%
Cumulative Percentage	50.00%	60 00%	66.00%	77 33%	90 67%	100 00%	100 00%	_
of Events per Year	50.0070	00.0070	00.0070	11.55/0	50.0770	100.00/0	100.00/0	-

Table 2 assigns the drug approval events to issuing firms. Again, we find no evidence of event clustering for singular firms. In total, our sample comprises of 10 companies with 5 or more events during the observation period from 1995 to 2009. More than 65% of our sample is attributable to firms with 4 or less events for the time of examination. Almost one quarter of the event sample is attributable to firms with one event each. Hence, our sample is not driven by any few firms adding disproportionally many events to our overall data set.

Table 2

Event Distribution across Sample Firms

This table provides information on the event distribution accross sample firms. It includes 150 drug approval decisions by the EMEA from 1995 to 2009. *Event class* refers to the number of events exhibited by any single firm in the entire sample. The second column reports the *number of firms per event class*. The third column is the product of the first and second column and displays the *total number of events in each event class*. The fourth column reports the fraction of events for each event class. The fifth column displays the cumulated frequency of events for each event class.

Event class	Firms per	Total events	Events as %	% of Total,
(events per	event class	in each class	of Total	cumulated
firm)				
1	34	34	22.67%	22.67%
2	10	20	13.33%	36.00%
3	8	24	16.00%	52.00%
4	5	20	13.33%	65.33%
5	2	10	6.67%	72.00%
6	3	18	12.00%	84.00%
7	1	7	4.67%	88.67%
8	1	8	5.33%	94.00%
9	1	9	6.00%	100.00%
Totals	-	150	100.00%	-

An overview of key financials for the sample firms is summarized in table 3. Due to missing data, the total number of observations does not add up to 65 for each financial and fiscal year. We find an increasing trend in R&D expenditures over time. Total firm leverage measured as the ratio of long-term debt out-

standing to total assets remains rather stable over time.

Table 3

Summary of Key Financials for the Sample Firms

This table provides information on the financials of the sample firms. Data was retrieved from Worldscope. We report figures consistent with the event sample period from 1995 to 2008. Data on year 2009 was not available yet. Nobs refers to the number of firms for which data was available in the respective years. Mean and median numbers are reported. SD refers to the standard deviation of the respective figure in the sample. A definition of the variariables reported is included in the appendix.

https Expension Sele Total Acets Interface Notice Capacity Capacity <th< th=""><th></th><th></th><th></th><th>R&D</th><th></th><th></th><th></th><th></th><th>D</th><th>D</th><th>Total Debt in</th><th>LT Debt in %</th><th>Managed</th><th>BS Should</th><th></th><th>5</th></th<>				R&D					D	D	Total Debt in	LT Debt in %	Managed	B S Should		5
Changes Sales Canada Canada<			K&D Exponsor	Expenses to	Net Income	Sales	Total Assets	Intangibles	Accotc	Return on	% of Total	of Total	Yearend Markot Cap	Dividend	Cashflow	Free
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Mean 1110 Jorgi J. 102009 110 2029 140 JS31 2995 JS3 101 JS3 110 JS3 JS3 JS317 JS1 JS315 JS1 JS315 <thjs1 js315<="" th=""> <thjs1 js315<="" th=""> J</thjs1></thjs1>		Nobs	51	51	52	52	52	51	52	52	52	52	52	46	52	52
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30 101 201		Median	5/3.992195	16.54454	391.666233	4286.73109	6307.89564	1470.40989	8.25416	16.838582	26.0121	27.146085	120/9.46/6	27.845995	589.403084	294.888405
Mean 111/1 246/31 94.079/17 124.79/20 950/218 950/218 95.079/26 95.579/27 95.079/27 95.071/27 95.071/27 95.071/27 95.051 95.071 95.071/27 95.051 95.071 95.051 <t< td=""><td></td><td>SD</td><td>1619.78178</td><td>84.2845306</td><td>2263.9494</td><td>12594.788</td><td>21989.7065</td><td>11347.5145</td><td>16.6962772</td><td>263.715496</td><td>21.8953861</td><td>58.9321647</td><td>30480.0978</td><td>21.9935004</td><td>2998.90606</td><td>1597.94357</td></t<>		SD	1619.78178	84.2845306	2263.9494	12594.788	21989.7065	11347.5145	16.6962772	263.715496	21.8953861	58.9321647	30480.0978	21.9935004	2998.90606	1597.94357
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Mean IDS ISSNE 711701 R8877025 INFL ISSN ISSNE 717539 ISSNE 71753		Nobs	57	57	58	58	58	56	58	58	58	58	58	53	58	58
Median PS 389381 115 / 782 273.62347 2270.0022 4369.04273 503.5445 7.43785 12.22555 9.1247255 12.047756 22.047756 22.047756 22.047756 22.047756 22.047756 22.047756 22.047756 22.047766 12.06404 13.05516 12.2255 9.047716 55 56 60 60 60 60 60 55 55 60 60 55 55 50 65 55 50 65 55 50 60 60 60 60 60 60 55 55 50 55 50 50 50 50 50 50 50 50 50 50 50 50 50 55 50 50	2006	Mean	1096.15988	181.256637	1379.11701	8836.79025	14912.4488	5841.11263	1.50590155	17.5195451	25.8194203	32.804021	29140.0253	21.2149764	1920.92586	892.136897
SD 1155 50217 790.28803 1267.2564 1297.583 24.782.67 22.2255 30.922.615 58.70195 4027.4315 18.564.04 307.2305 1485.661 55 60 60 60 59 55 60 60 2005 Mean 1030.0052 19.97478 122.82.82.97 413.842 138.616 457.37886 2.0304827 61.72174 22.857.57 21.854.441 143.7128 2.1294 41.01049 21.73273 2.441.4273 24.84939 200 149.01067 112.94.208 200.6492.55 112.41.845 204.44726 10.409.397 21.877.559 7.857.59 7.857.55 2.457.557 14.953.55 14.99.377.53 9.45.120 14.010.44.447.53 14.99.377.53 9.457.557 14.93.555 7.93.518 9.57.557 7.93.518 9.457.294 14.95.297.557 14.93.556 7.93.518 9.457.294 14.95.357.557 14.95.257.557 14.93.556 7.93.518 9.57 5 5 5 5 5 5 5 5 5 <	2000	Median	375.389381	15.6728	273.623475	2370.00292	4369.04273	505.3643	7.847845	14.6510835	17.738525	19.249795	13055.158	22.66941	420.470485	346.76374
Nobs 59 58 60 60 60 60 60 59 55 60 60 2005 Medan 330,0737 15,3813 306,0251 223,3423 55,390262 2,334453 37,57212 221,35435 31,72172 212,5453 41,10,0253 22,8448439 37,57212 37,44045 31,72173 37,4404 343,10753 22,8448439 Nobs 59 58 60 60 50 58 50 60 58 55 60 55 2004 Medan 92,17427 16,4255 258,211145 31,4422961 22,92172 18,80274 13,80326 15,85327 47,05411 14,41171 13,44256 25,757 33,8437 32,07054 14,85327 14,7553 24,11173 14,84529 22,9216 24,11173 13,8454 14,7553 24,11173 13,8454 14,7553 14,85214 14,75171 13,8454 14,7553 14,81504 14,9171 13,844 14,11171 13,844 14,11171		SD	1505.50217	790.289803	2267.25664	12460.0135	22862.5665	12977.5839	24.7382637	92.3226556	30.9422615	58.7201959	40272.4315	19.696404	3037.23036	1485.66815
Mean Indou.0562 199.9478 1228.2247 841.342 138.2716 457.3788 27.38286 25.3344837 31.721/42 281.2475 12.835744 (17.43778) 25.37389 SD 1400.1062 119.2308 2006.8929 12.44146 10.40397 11.71773 12.837444 11.71729 12.71717 17.85176 24.48120 22.458125 42.11227 19.714468 11.717297 12.71717 17.85176 36.85189 54.21127 19.8172446 11.717297 12.71717 17.85176 36.85182 54.21127 19.817246 14.917297 12.829100 24.671173 13.564.47 37.91716 38.712717 13.91716 38.71287 34.77173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.47 37.911173 13.564.477 37.911173		Nobs	59	58	60	60	60	58	60	60	60	60	59	55	60	60
Median 392,01/35 15,38013 00x,08029 12/14/38 2004,391 6x097/s 12/12,020809 22/14/38 25/14/31	2005	Mean	1000.05052	199.976478	1228.82347	8413.424	13386.716	4357.37988	2.7382485	55.3906263	23.3344837	31.7521742	28125.4758	21.2894444	1744.37739	825.973993
SD 1430 (1992) 1123 (2008 2005) 1244 (11248) 1024 (11248)		Median	339.207375	15.38013	306.205161	22/2.64912	4259.30213	650.9321	8.695775	17.855726	20.367095	20.44339	85/3.38916	20.2198	431.070593	128.848039
Number 937.27717 70.582/248 916.16607 702.8282 12.399727 78.802/20 12.484280 27.292/248 24.377.098 25.572 138.64502 24.477.098 Median 937.27717 70.582/248 206.17425 152.9486 207.1872 138.6450 23.29972 78.802/20 12.484283 24.470544 337.528248 24.370.048 137.5728 24.4712 Nobs 58 56 59 56 54 59 59 59 55 54 59 56 54 59 56 54 59 56 54 50 57 138.6452 25.65287 21.848252 23.84242		SD	1430.10692	1129.32038	2006.89295	12141.3485	20644.4726	10409.3987	21.16/0213	292.089059	22.4591245	45.2112237	39754.0463	21.7528733	2/43.16288	1491.70023
Median 296.1742/9 16.422455 252.001282 290.00541 3179.1218 548.53718 20.251076 19.89006 16.958454 770.94119 19.43106 387.79222 199.19206 Nob 58 57 527.957 20.017 59.35583 20.251076 19.89006 16.958477 25.757 21.011075 192.959 65.52777 200 Median 224.2218 10.545805 20.03 23.88.867 102.222.86 166.4207 10.90064 18.93575 18.93170 18.93757 18.93100 123.7577 120.91016 101.57.0773 Nob 58 57 61 61 50 9 9 9 9 9 9 9 101.73.0797 400.013188 200 Median 326.996688 158.77 71.01.0278 10.933355 105.77 14.41474 52.88.1766 123.77714 44.013184 11.937569 123.77714 14.448345 11.63.7077 159.57 16.952177 123.44814 12.8600757 10.933385 11.		Mean	937 277817	70 5362438	936 166901	7302 83281	11945 7184	3844 62963	2 32992729	7 88802343	21 4848593	27 2862485	24377 0908	25 1265773	1386 45182	50 644 447197
SD 1449.98763 201.181974 1953.5583 20.851825 58.247462 18.583722 34.705743 1574.5887 28.282006 24.71173 1356.447 Nobs 58 55 50 50 55 56 55 55 56 55 55 56 55 56 55 55 56 55 56 55 50 50 51 57 51 57 51 57 51 55 52 55 55 55 52 55 52 55 55 55 55 50 51 57 50 57 56 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 <td>2004</td> <td>Median</td> <td>296.174229</td> <td>16.422455</td> <td>258.201828</td> <td>2507.05043</td> <td>3379.15218</td> <td>548.537218</td> <td>8.43302</td> <td>12.261076</td> <td>19.80996</td> <td>16.958245</td> <td>7790.94119</td> <td>19.43106</td> <td>338,750222</td> <td>199,198206</td>	2004	Median	296.174229	16.422455	258.201828	2507.05043	3379.15218	548.537218	8.43302	12.261076	19.80996	16.958245	7790.94119	19.43106	338,750222	199,198206
Nobs 58 56 59 54 59 59 59 56 54 59 57 2003 Median 224,72281 15,455805 208,33 238,8626 263,75373 21,1155 21,420,837 18,1955 784,35268 18,579755 384,346,371 221,014827 50 1178,32238 100,358651 1476,6528 1022,5285 16645,2107 750,14677 16,3920943 32,563143 17,6947039 21,701278 4033,18941 23,373742 188,084071 212,014827 2002 Mean 686,100,786 73,16175 721,320787 739,735559 1055,75746 -04,1073254 18452026 20,1382509 10,331168 244,17279 20,385689 1123,8704 420,225 16,9947738 247,61146 32,002471 10,379526 39,269,947 10,217157 258,5123 10,804285 10,45148 10,50428 22,024779 23,3842847 10,41345 11,04543 22,04274 10,379526 39,269,947 11,212,1797 258,51459 32,517,517,313,444,44541 <t< td=""><td></td><td>SD</td><td>1469.98763</td><td>201.181974</td><td>1952.99486</td><td>10715.7035</td><td>18576.477</td><td>9533.55836</td><td>20.5851825</td><td>58.2474362</td><td>18.5383722</td><td>34.7057451</td><td>35745.8837</td><td>28.928106</td><td>2467.11173</td><td>1356.445</td></t<>		SD	1469.98763	201.181974	1952.99486	10715.7035	18576.477	9533.55836	20.5851825	58.2474362	18.5383722	34.7057451	35745.8837	28.928106	2467.11173	1356.445
Mean 824.29739 38.422724 794.30018 7012.786 1026.0224 20.88.2056 21.420234 21.48.0256 2973.573 21.011952 1215.599 65.528727 SD 1178.3228 100.38651 1476.6583 10225.286 1665.107 7501.4677 16.392084 32.55141 17.647703 21.011278 4031.8414 23.373762 188.0078 55 5 5 5 5 5 5 5 5 5 5 7 55 10.257.073 23.03658 1123.8707 460.081388 2002 Median 326.95688 15.8874 203 2480.1949 303.1918 62.43157 7.01475 256.2021 10.92157 238.4568 23.07178 23.086897 11.02175 230.5218 200.01187 14.004187 174.042783 23.086987 11.021757 258.4568 23.07028 12.0801 14.04127 12.48205 10.250.777 20.0218 12.014274 11.388970 460.081388 23.07313 244.43215 21.0111175 258.25275		Nobs	58	56	59	60	59	54	59	59	59	59	56	54	59	57
Median 284.7228 1 11.545505 208.3 238.8487 322.9528 50.25742 18.8037 18.1955 74.89526 18.19575 38.496371 221.04227 Nobs 58 57 61 61 65 59 61 61 61 55 54 61 55 200 Median 326.9688 15.8874 203 2480.1499 300.15918 62.45717 57 56 55 56 54 54 56 55 56 54 54 56	2002	Mean	824.29739	38.4527284	794.30018	7012.7369	10626.0224	3058.72436	2.24352305	3.07116156	21.4420334	23.8842256	25735.7537	21.8011952	1215.9599	626.528727
SD 1178.32238 100.358651 1476.6583 1025.2586 16465.2107 750.4677 163.290043 32.563143 17.6947039 21.711278 40331.8014 12.3737642 188.04079 1167.370754 2020 Mean 866.100783 67.3161875 71.32087 7393559 10659.5244 255.75746 0.4079254 1.8825022 20.1825092 20.331108 26424.7279 20.33568 112.37077 258.5432 1.800075 27.6144 SD 1173.70961 23.375428 242.451049 10601.877 14740.8746 5268.17550 23.377614 48.0025 15.59574 10.378526 39269.9547 21.0271577 258.54352 158.0756 30.07731 484.48345 410.65425 2001 Median 35.55169 34.02011 1095.5885 84.05631 1026.0757 59 56 56 54 57 56 56 54 57 56 56 54 56 54 56 54 56 54 56 56 54 56	2003	Median	284.72281	15.455805	208.3	2338.8367	3325.96289	540.271126	6.70058	10.567242	18.89037	18.19556	7843.95268	18.579755	384.946371	221.034827
Nobs 58 57 61 61 65 59 61 61 61 55 54 61 60 2002 Median 326.996698 15.8374 203 208.01999 3903.1991 624.91517 12.38794 62.08138 212.83794 22.852.175 23.317646 48.02025 15.92547 19.379526 39269.9547 21.027157 2589.5432 21.80.02755 258.54325 19.379526 39269.9547 21.027157 2589.5432 180.09255 2001 Mean 903.0839 61.922511 109.95838 8149.0261 1225.812 266.06433 20.904751 27.86216 19.401661 11.52917 40242.2831 258.2578 144.43843 141.0552 200 Mean 904.558169 34.020814 110.9775 57 57 57 56 55 54 54 57 57 57 57 57 56 55 55 55 54 54 57 57 57 57 57		SD	1178.32238	100.358651	1476.6583	10225.2586	16645.2107	7501.4677	16.3920943	32.563143	17.6947039	21.7011278	40331.8041	23.3737642	1880.84079	1167.57073
Mean 866.100783 67.3161875 721.32087 739.35559 1055.5244 257.67146 64.802025 20.393108 264.47.279 20.335689 1123.8707 460.08188 SD 1173.70961 233.754268 2443.1104 10001.8757 1474.08746 528.1755 15 5 59 57 56 56 54 54 57 55 56 54 54 57 55		Nobs	58	57	61	61	61	56	59	61	61	61	55	54	61	59
Median 326.996898 15.88744 203 2480.19499 390.19918 624.91572 7.04439 10.084489 19.02808 14.2885 7946.77822 17.64136 321.07157 228.95457 123.07157 228.95457 123.07157 228.95457 123.07157 228.95457 123.07157 228.95457 123.07157 228.95457 123.6516485 420.07157 228.9575 155.756485 422.67024 Median 357.6399 145.2105 305.251361 2856.3186 403.40702 658.363751 7.15244 12.186601 14.24917 12.48206 1025.00555 20.77313 444.438345 141.05452 2000 Meain 90.4558169 33.4208814 110.97851 786.29677 978.5307 17.475182 24.467447 19.135951 20.406504 4291.1323 20.9559485 13.09252 13.67851 41.49431 7.92.6097 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	2002	Mean	868.100783	67.3161875	721.320878	7397.35559	10659.5244	2557.67146	-0.41079254	1.84520262	20.1825092	20.3931108	26424.7279	20.3385689	1123.87907	460.081388
SD 11/3 / 10/61 23/3 / 24/28 24/24 / 51/09/1 11/40/8/76 26/26 / 12/25 12/3 / 10/21 12/3 / 10/21 22/3 / 25/26 32/26/34 22/10/21/27 22/38/24/28 2/3/38/24/28 2/3/38/24/28		Median	326.996898	15.88744	203	2480.19499	3903.19918	624.915172	7.04439	10.084489	19.02808	14.28585	7946.77582	17.641365	351.13/349	27.62144
Nobs 50 1095,8385 8149,60261 1259,8128 2800,4453 2.900,47351 -27,860210 19,4010661 12,2582257 155,764943 22,582257 155,764943 22,582257 155,764943 22,582257 155,764943 22,582257 155,764943 12,48206 10250,0855 20,77313 444,48345 141,04512 2000 Mean 905,8516 34,502051 107,8757 155,757 550 56 56 54 55 57 550 56 56 54 55 55 513,09257 449,80343 2000 Mean 905,8516 34,00054 1209,8016 1067,875 118,13327 29,8046 120,91076 27,5101497 104,56485 118,878561 13,67851 141,97411 79,60907 115,5472 55,95475 55 55 55 55 55 55 51 52 55 55 51 52 55 55 55 51 52 55 55 51 52 55 55		SD	11/3./0961	233.754268	2424.51049	10601.8757	14/40.8/46	5268.17556	23.31/6146	48.02025	16.592547	19.3795266	39269.9547	21.02/15//	2589.54352	1380.09255
2001 Median 357.6393 14.52105 305.251361 2685.6318 403.40702 685.83751 7.1524 12.48200 102.80.0955 20.7733 444.438345 141.0452 SD 1235.44317 159.38935 185.21278 1170.7675 19659.7675 587.33857 17.4875189 206.45557 20.00398 27.348125 58318.6669 20.960785 20.998.9616 1681.8303 2000 Median 904.558169 33.400814 100.47851 7665.2977 9878.53307 191.3327 2.9457342 4.467487 19.1359516 20.450564 2491.971 12.04049 11.75894 10.04685 11887.8516 13.67851 141.4741 79.260907 1999 Median 320.58149 42.057071 82.26666 459.355 1488.1502 339.10744 18.08685 51.8487111 10.017656 75.101497 6094.28864 2.598472 230.27034 239.29816 1999 Median 329.168145 13.71931 147.74040 239.20873 15.246775 51.59756 5 5 <td></td> <td>Mean</td> <td>909 08359</td> <td>61 9226911</td> <td>1099 58385</td> <td>8149 60261</td> <td>12259 8128</td> <td>2680 64453</td> <td>2 90047351</td> <td>-27 8602106</td> <td>19 4010661</td> <td>21 2552775</td> <td>40242 2831</td> <td>22 5822575</td> <td>1567 66485</td> <td>492 670249</td>		Mean	909 08359	61 9226911	1099 58385	8149 60261	12259 8128	2680 64453	2 90047351	-27 8602106	19 4010661	21 2552775	40242 2831	22 5822575	1567 66485	492 670249
SD 1235,44317 159,38935 1852,1278 11702,767 1965,767 5887,33857 17,487519 29,6453557 20,553983 27,348125 58318,8698 22,9660785 239,989616 1681,8303 2000 Mean 904,555169 33,4209814 1107,4751 756,5577 50 54 57 56 56 54 54 57 55 Mean 904,555169 33,4209814 10,47817 756,8577 198,3347 2,9457342 4,467481 10,456043 1187,8561 13,67851 414,97431 79,260907 SD 1156,5472 55,9492847 197,75861 10678,3755 128,1042 31,40748 18,08695 51,8487111 20,910763 27,5101497 1042,848 12,6773 31,359179 76,11603 20,690785 20,711033 2444,337 12,830145 12,80114 117,54823 293,92316 1107,135 59,5116 55,90873 293,92361 59,5116 55,90873 20,711033 2446,3370 12,801141 117,913,8161 55,908731 17,913616 <td>2001</td> <td>Median</td> <td>357.63993</td> <td>14.52105</td> <td>305.251361</td> <td>2685.63186</td> <td>4053,40702</td> <td>658.363751</td> <td>7.15244</td> <td>12.186601</td> <td>14.24917</td> <td>12,48206</td> <td>10250.0955</td> <td>20,77313</td> <td>444,438345</td> <td>141.05452</td>	2001	Median	357.63993	14.52105	305.251361	2685.63186	4053,40702	658.363751	7.15244	12.186601	14.24917	12,48206	10250.0955	20,77313	444,438345	141.05452
Nobs 53 51 57 57 57 50 54 57 56 56 54 57 55 2000 Mean 904,558169 33.202814 1109,47851 7686.2677 9878.53307 1916.33327 2.94573426 4.467487 19.1359516 20.4606504 42491.1323 20.9559485 136.07851 141.497431 7.9260907 50 1156.5472 55.9492847 177.7585 1281.5042 3394.1074 18.086859 51.8487111 20.9107636 27.5101497 60942.8864 2.25984276 2302.77046 983.196497 1999 Mean 780.584196 42.0570471 829.26646 6449.53058 8488.3973 1622.46775 -3.13591759 76.116063 20.6906785 20.701803 28448.3701 21.805111 117.54892 29.3923851 1999 Mean 780.584196 42.0570471 829.26646 6449.5308 848.3977 12.926834 179.95207 12.40056 15.98705 11.65093 6442.53452 19.9374166 55.996923 19.		SD	1235.44317	159.38935	1852.12788	11702.7675	19659.7675	5887.33857	17.4875189	296.453557	20.5053983	27.3438125	58318.8698	22.9660785	2399.89616	1681.8303
Mean Median 904,558169 33,4209814 1109,47821 7686,29677 978,53301 1916,3322 2,9457342 4,467487 19,1359516 20,060504 42491,1223 20,955845 1520,9527 49,803431 Dob 115,65472 55,940281 123,33333 233,30583 233,30583 233,105437 7,7508 10,45645 1187,8561 13,67851 144,97431 79,26090 Dob 50 50 49 55 56 55 46 54 56 55 51 52 56 55 56 55 55 51 52 56 55 55 55 51 52 55		Nobs	53	51	57	57	57	50	54	57	56	56	54	54	57	55
Median 318.302125 13.8332 23.39333 2438.5063 35.49.9228 57.737441 7.7508 12.04049 11.75894 10.456455 11887.851 13.6781 414.9731 79.260907 SD 1156.5472 5.9492847 797.58651 10678.3755 12881.5042 3394.10748 18.08689 51.8487111 20.9107636 27.510147 60942.8864 22.598272 2302.7704 983.196497 1999 Mean 780.584196 42.0570471 829.26465 6449.53058 848.39771 1622.46775 51.13591759 76.116063 20.6906785 20.701803 2844.83701 21.805111 1175.4822 29.322381 1999 Median 329.168146 138.77490 521.35373 122.40575 51.89510 11.63093 642.53452 19.35613 54 54 54 54 54 54 54 54 54 54 54 54 54 54 54 54 54 54 54 52 54 54 52 54 <td< td=""><td>2000</td><td>Mean</td><td>904.558169</td><td>33.4209814</td><td>1109.47851</td><td>7686.29677</td><td>9878.53307</td><td>1916.33327</td><td>2.94573426</td><td>4.467487</td><td>19.1359516</td><td>20.4606504</td><td>42491.1323</td><td>20.9559485</td><td>1530.95257</td><td>449.880343</td></td<>	2000	Mean	904.558169	33.4209814	1109.47851	7686.29677	9878.53307	1916.33327	2.94573426	4.467487	19.1359516	20.4606504	42491.1323	20.9559485	1530.95257	449.880343
SD 1156.5472 55.942247 1797.5863 10678.375 1288.1542 3394.1074 18.086859 51.848711 20.9107636 27.511497 6094.2864 22.588472 2302.7706 983.196407 1999 Mean 780.584196 42.0570471 829.2664 6449.53058 8488.39773 162.46775 -3.13591759 76.116063 20.6906785 20.701803 28448.3701 21.805111 1175.48923 29.323851 50 934.651379 10.339644 18.04508 380.82743 1120.15434 272.07064 12.404356 15.98705 11.61093 6442.5342 19.361315 250.91816 55.9006923 19.30107135 55.9006923 10.7913207 50.30107135 50.30107135 50.30107135 50.3107135 50.3107135 50.3107135 50.3107135 50.3107135 50.3107135 50.3107135 50.317451 129.9069253 51.47619 19.9869253 56.692171 19.37464 53.053 51.4519 14.9752902 56.502175 13.217575 53.53 54 48 52 51.51 50.555	2000	Median	318.302125	13.88351	235.393538	2438.50663	3549.92628	576.737441	7.7508	12.04049	11.75894	10.456485	11887.8561	13.67851	414.97431	79.260907
Nobs 50 49 55 66 56 56 55 51 52 56 53 1999 Mean 329.168145 13.7193 187.73400 213.54635 325.85316 325.197387 7.19563 12.440356 15.98705 116.3033 6442.53452 19.365135 256.91816 55.906923 50 948.65179 102.39644 1380.45608 893.08274 1201.01543 2720.70952 28.283641 479.95207 22.002064 29.402720 40155.4048 20.374443 1701.120 63.010135 1998 Mean 594.695106 62.6163511 589.08274 1207.9762 28.283641 479.95207 22.002642 29.402278 40155.4048 970.1120 63.010135 1998 Mean 594.695106 62.6163511 589.0823 230.72452 6.672 11.29438 16.18719 14.97258 566.92177 19.37446 165.30783 6.4304050 1998 Median 301.36636 13.34095 143.17933 4745.3528 852.21411		SD	1156.5472	55.9492847	1797.58651	10678.3755	12881.5042	3394.10748	18.086859	51.8487111	20.9107636	27.5101497	60942.8864	22.5984276	2302.77046	983.196497
Median 780.584195 42.0570471 829.26466 6449.53058 8488.39771 1622.46775 -3.13591759 76.116063 20.6906785 20.7018033 28448.3701 21.805111 1175.4823 293.923815 5D 948.651379 102.398644 1380.4580 8930.82743 11201.5434 2720.70962 28.283641 479.952907 22.002684 29.4027208 40155.4048 20.3744443 1790.13207 630.107135 1998 Mean 594.695106 62.6163511 583.3057 502.375594 648.4755 122.06354 -399588257 18.581191 14.975285 5666.2177 19.3746 155.30783 64.304005 1998 Mean 504.05636 64.30335 606.30123 174.75441 277.90464 20.72542 6.7672 11.29438 16.18191 14.975285 5666.2177 19.3746 155.30783 64.304005 50 678.72188 16.2643495 998.61944 7435.3596 852.24111 10.505217 15.889786 29.984527 18.3818 19.93614 147.5775117		Nobs	50	49	55	56	55	46	54	56	55	55	51	52	56	55
Michain 5.29.16913 10.7.3930 107.3930 123.3403	1999	Mean	780.584196	42.05/04/1	829.26646	6449.53058	8488.39773	1622.46775	-3.13591/59	/6.116063	20.6906785	20.7018033	28448.3701	21.805111	11/5.48923	293.923851
Jobs Jobs <th< td=""><td></td><td>sp</td><td>948 651379</td><td>107 398644</td><td>1380 45806</td><td>2133.54035</td><td>11201 5434</td><td>323.197387</td><td>7.19505</td><td>12.440350</td><td>22 0202684</td><td>20 4027208</td><td>442.55452</td><td>20 374443</td><td>1700 13207</td><td>55.900925 630 107135</td></th<>		sp	948 651379	107 398644	1380 45806	2133.54035	11201 5434	323.197387	7.19505	12.440350	22 0202684	20 4027208	442.55452	20 374443	1700 13207	55.900925 630 107135
Instruct Space		Nobs	46	46	1300.43000	54	54	2720.70502	53	475.552507	54	54	40133.4048	20.3744443	54	52
Hedian 301.36636 13.334095 66.630123 1374.75441 2779.0464 20.72545 6.7672 11.29438 16.18719 14.972585 566.69.2177 19.3746 156.360783 6.4304005 SD 678.72188 16.2.643495 98.61944 7435.356 882.24111 2054.19416 34.606050 19.97179 15.889785 29.984287 38346.62 20.032421 131.7193 475.77511 1997 Meain 550.02158 35.7906951 491.038517 4984.36033 604.27725 10.57.2237 4.8107059 7.11282792 16.48189 13.9003 4562.2164 19.452064 747.84869 181.623007 SD 648.946955 82.20167 955.45611 1057.2237 4.8107059 7.11282792 16.48189 13.9003 4562.2164 18.55003 145.029645 29.390263 SD 648.946956 82.20167 95.456511 727.84981 807.09446 202.60177 11.82182 12.821843 30.202.228 19.624801 12.471.83 479.748482 1996 <td< td=""><td></td><td>Mean</td><td>594.695106</td><td>62.6163511</td><td>589.340557</td><td>5023.76594</td><td>6481.4755</td><td>1229.68354</td><td>-3.99588925</td><td>34.1955992</td><td>18.8541174</td><td>21.6567235</td><td>25742.2995</td><td>19.9869253</td><td>853.147619</td><td>199.553635</td></td<>		Mean	594.695106	62.6163511	589.340557	5023.76594	6481.4755	1229.68354	-3.99588925	34.1955992	18.8541174	21.6567235	25742.2995	19.9869253	853.147619	199.553635
SD 678,721838 162,643495 998,61949 7435.3596 885.24111 205,1111 34,6906508 169,791719 15.889785 29.984527 38346.62 20.032421 1331.71931 475.775177 1997 Mean 50021598 35,7906951 491.038517 4984.3603 60947275 157.27517 4.810079 7.1128729 15.882598 20439.9611 19.436104 747.84691 18.1623807 Mean 287.26907 12.49667 93.05051 1500.6703 1621.9291 155.55216 6.11621 9.682573 16.48189 13.003 4562.21694 18.5503 145.029645 29.39063 50 648.94695 82.22167 956.456511 773.84981 8507.0944 0.23.60759 11.297627 13.82884 30240.228 19.624301 147.1933 19.743401 147.1933 19.743401 147.1933 19.47149 4.84 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94 4.94	1998	Median	301.36636	13.334095	66.630123	1374.75441	2779.04646	230.725452	6.7672	11.29438	16.18719	14.972585	5666.92177	19.37446	156.360783	6.4304005
Nobs 46 45 53 53 53 43 51 53 53 53 48 48 52 51 1997 Mean 560.02159 35.7906951 491.038517 498.43603 6094.27725 1057.22376 4.81207059 7.11282792 16.484377 15.802593 20439.9614 19.4361604 747.84869 18.023807 50 648.946956 82.20167 956.456511 727.84981 8507.09446 20.3260781 33.2897435 60.2364759 11.2979627 13.82884 30240.228 19.6243801 1245.0294 29.390263 1996 Mean 498.731457 113.461309 474.157216 4387.75208 500.04049 807.42552 0.32736744 16.151125 17.214631 12956.6489 22.366107 714.70903 142.13291 1996 Mean 498.731457 113.461309 474.75208 5400.40439 807.42552 0.32736744 16.151125 17.214631 12956.6489 22.366107 714.70903 142.13291 42.4849 22.366107 <td></td> <td>SD</td> <td>678.721838</td> <td>162.643495</td> <td>998.619494</td> <td>7435.3596</td> <td>8852.24111</td> <td>2054.19416</td> <td>34.6906508</td> <td>169.791719</td> <td>15.8897985</td> <td>29.9845287</td> <td>38346.662</td> <td>20.0324621</td> <td>1331.71931</td> <td>475.775117</td>		SD	678.721838	162.643495	998.619494	7435.3596	8852.24111	2054.19416	34.6906508	169.791719	15.8897985	29.9845287	38346.662	20.0324621	1331.71931	475.775117
Mean S60.02158 35.7906951 491.038217 4984.36033 6094.27725 1057.22376 -4.8120705 -7.1128279 15.8443572 15.82583 2043.9614 19.4361604 747.8469 181.623807 5D 648.946956 82.220167 965.456511 7273.84981 807.09446 2023.60781 33.289745 60.2364759 11.2975627 18.82884 30240.2288 16.52180 1247.1834 477.8469 181.623807 37.44842 1995 Mean 498.714575 113.46130 747.177484 807.09446 2023.60781 33.289745 60.2364759 11.2975627 18.82884 30240.2288 16.243801 1247.1834 477.44842 1995 Mean 498.714575 113.46130 471.57164 38.77508 800.40439 807.42582 0.32736474 16.51012 17.24581 22.366107 71.40938 142.13291 1996 Mean 498.71457 11.46130 476.9471 13.249964 11.5755817 13.41998 18.8798 131.75104 54.84842 50	-	Nobs	46	45	53	53	53	43	51	53	53	53	48	48	52	51
Median 287.269907 12.49667 39.00501 1500.67303 162.19281 155.552.16 6.11621 9.682573 16.48189 13.9003 4562.21694 18.55203 145.029645 29.390263 SD 648.946956 82.20167 965.456511 7273.84981 8507.09446 2023.60781 33.2897435 60.264759 11.297927 13.82884 30240.228 19.6243001 1247.1835 479.748482 1996 Mean 498.731457 113.461309 474.157216 4387.75208 540.04039 807.425582 0.32736744 -16.1511245 17.5458696 17.2114633 12956.6489 22.3661077 714.709038 194.213291 Median 284.608398 10.841035 821.775888 1762.07223 175.72416 176.009147 16.65649 10.399474 16.70032 14.93506 373.8709 18.8798 131.751049 54.804842 SD 574.046035 574.0667396 754.954701 133.07855 27.1578861 134.75548 11.5756517 18.85491 22.361208 101.127324 23.816208 <td>1997</td> <td>Mean</td> <td>560.021598</td> <td>35.7906951</td> <td>491.038517</td> <td>4984.36033</td> <td>6094.27725</td> <td>1057.22376</td> <td>-4.81207059</td> <td>-7.11282792</td> <td>16.4843572</td> <td>15.8025953</td> <td>20439.9614</td> <td>19.4361604</td> <td>747.84869</td> <td>181.623807</td>	1997	Mean	560.021598	35.7906951	491.038517	4984.36033	6094.27725	1057.22376	-4.81207059	-7.11282792	16.4843572	15.8025953	20439.9614	19.4361604	747.84869	181.623807
SD 648.94695 82.220167 955.456511 727.84981 8507.0946 2023.60731 33.2897435 60.2364759 11.2979627 13.82884 30240.2288 19.624801 1247.1835 479.748402 1996 Mean 498.731457 113.461309 474.157216 4387.75208 5400.40439 807.42558 0.32736744 16.1511245 17.5458666 17.2114633 12956.6489 22.366107 714.709038 194.213291 Median 284.60398 10.841035 82.179688 176.207223 2175.7246 16.1511245 17.5458666 17.2114633 12956.6489 22.366107 714.709038 194.213291 Median 284.60398 10.841035 82.179688 176.207292 175.72416 1360.37855 21.751866 13.475694 11.576517 13.241090 17818.566 22.36107 714.709038 292.232345 Mobs A 43 43 43 43 43 43 43 43 43 43 43 43 44 44 44 44	1557	Median	287.269907	12.49667	93.050501	1500.67303	1621.92891	155.562146	6.11621	9.682573	16.48189	13.9003	4562.21694	18.55203	145.029645	29.390263
Nobs 42 42 51 51 64 74 74 743 1996 Mean 498,731457 113,46130 471,57216 487,75208 5400.40439 807,42528 0.3273,6741 15.15 51 51 51 51 51 56 46 47 49 45.3 1996 Mean 498,731457 113,461309 474,157216 487,75208 5400.40439 807,42528 0.3273,6744 16.51124 17.545866 17.211463 12956,6489 22.366107 714,709038 194,213291 50 547,346603 574,026652 716.44058 646,7399 749,7924 13.03,7852 27.159186 14.3475641 115,761847 13.241909 1818.666 22.361007 714,70938 128.2334 24.231541 28.23345 24.231541 28.23454 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.231541 24.23154		SD	648.946956	82.220167	965.456511	7273.84981	8507.09446	2023.60781	33.2897435	60.2364759	11.2979627	13.828884	30240.2288	19.6243801	1247.1835	479.748482
Mean 498./343/s 113.461309 4/4.15/11 438//3208 50//3208		Nobs	42	42	51	51	51	40	43	51	51	51	46	47	49	45
Wetchain 244,003396 10.841033 62.173066 1762.072.52 217.572410 136,003947 10.8398/4 10.7002 14.3306 537.3367/3 16.8639 151.73149 34.004947 34.004947 50 547.346603 574.02652 7549.57309 7549.5701 1330.37855 27.159186 143.47564 113.261909 1818.5666 22.3616208 1011.27324 282.2345 Nobs 40 43 44 43 43 43 43 44	1996	Mean	498./3145/	113.461309	4/4.15/216	4387.75208	5400.40439	807.425582	0.32/36/44	-16.1511245	17.5458696	17.2114633	12956.6489	22.3661077	/14./09038	194.213291
Jobs 40 40 43 43 34 43 40 40 40 43 41 1995 Mean 455 95731 57.766573 490.691881 4714.2667 5912.84824 750.285217 -0.61996651 -4.13203574 20.1544828 20.6025174 10430193 24.6115768 748.81357 106.122596 Median 295.320728 10.767285 160.43439 23.62099 3318.55891 128.097776 6.98074 13.090811 19.54808 18.89374 3648.88015 19.68955 318.796112 46.856579 S0 528.995076 165		sn	204.008398	10.641035	82.1/9688 716 440529	6456 73006	21/0./2410	1330 37855	0.08549	1/13 / 7560/	11 5765817	13 2410000	35/3.38/09	10.8/98	1011 27224	378 23245
Mean 465.957313 57.7466573 490.691881 4714.2627 5912.84824 750.285217 -0.61996651 -4.13203574 20.1544828 20.6025174 10430.1936 24.6115768 734.813157 196.122690 1995 Median 295.320728 10.767285 160.643439 2376.20959 3318.55891 128.097777 6.98074 13.090811 19.54808 18.89347 3648.88015 19.68955 318.796112 46.856579 SD 528.995076 165.95256 698.577468 6361.47641 7557.08119 1350.01679 24.9563044 55.6750915 12.3557402 14.513574 13427.1024 23.235109 987.531994 375.827261		Nobs		40	, 10.440JJ38	430.755590	. 343.34701	34	43	173.47.5054 43	11.5705017	13.2413038	40	22.3010208	43	J20.23343 41
1995 Median 295.320728 10.767285 160.643439 2376.20959 3318.55891 128.097777 6.98074 13.090811 19.54808 18.89347 3648.88015 19.68955 318.796112 46.856579 SD 528.995076 165.95256 698.577468 6361.47641 7557.08119 1350.01679 24.9563044 55.6750915 12.3557402 13.427.1024 23.235109 987.531994 375.827261		Mean	465.957313	57.7466573	490.691881	4714.26627	5912.84824	750.285217	-0.61996651	-4.13203574	20.1544828	20.6025174	10430.1936	24.6115768	734.813157	196.122969
SD 528.995076 165.95256 698.577468 6361.47641 7557.08119 1350.01679 24.9563044 55.6750915 12.3557302 14.513574 13427.1024 23.235109 987.531994 375.827261	1995	Median	295.320728	10.767285	160.643439	2376.20959	3318.55891	128.097777	6.98074	13.090811	19.54808	18.89347	3648.88015	19.68955	318.796112	46.856579
		SD	528.995076	165.95256	698.577468	6361.47641	7557.08119	1350.01679	24.9563044	55.6750915	12.3557302	14.513574	13427.1024	23.235109	987.531994	375.827261

IV. EMPIRICAL RESULTS

1. WEALTH EFFECTS

We test our sample of drug approvals for wealth effects upon the approval decision. Similar to previous works, we employ event study methodology and estimate a market model over a 150 trading-day period (e.g., Brown and Warner, 1985; MacKinley, 1997; Kothari and Warner, 2007) as well as a mean adjusted model. A 10 day gap is kept between each event window and the beginning of the estimation period to prevent our results from being biased by event-induced effects. The market return is proxied by the corresponding Datastream local market index for each sample company. The significance of the abnormal stock returns around the approval decision is tested via a standard t-test as well as a Boehmer-test (Boehmer et al. (1991)). Several event windows are studied to capture the stock price assessment around the new product introduction.

Table 4

Wealth Effects around New Product Introductions

This table reports the cumulative average abnormal stock returns (CAAR) to new drug approvals at the EMEA between 1995 and 2009. Returns are estimated via a market model as well as a mean adjusted model. Market model paramters are estimated using a 150 trading day estimation period where a 10 day gap is kept between the start of the estimation period and the beginning of the corresponding event window. Panel A reports market model results while panel B summarizes mean adjusted results. Abnormal returns are tested for significance using a t-test and Boehmer test. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Event window	CAAR	Boehmer Test	t-Test	Nobe
	CAAR	z-score	t-value	11003
Panel A: Marke	t Model			
[-1;+0]	0.79%	2.715***	2.815***	150
[0;+1]	0.84%	1.698*	2.204**	150
[-1;+1]	1.08%	2.432**	2.555**	150
Panel B: Mean	Adjusted N	<i>lodel</i>		
[-1;+0]	0.54%	2.162**	2.068**	150
[0;+1]	0.88%	2.035**	2.281**	150
[-1;+1]	0.94%	2.203**	2.221**	150

Table 4 provides the event study results for different event window lengths. The findings reveal significant wealth effects surrounding the approval decision of a new drug candidate. Results are robust to both the market and mean-adjusted model. Similar to previous studies of Bosch et al. (1994), Sharma and Lacey (2004), Sarkar and De Jong (2006), and Dedman et al. (2008), we also find a significant positive cumulative average abnormal stock return (CAAR) of 1.08% for the immediate time of one day prior and subsequent to the approval announcement measured via the market model. The CAAR [-1;+1] measured via the mean-adjusted model is 0.94% and significant as well. The positive announcement effects suggest that the exercise of the real option increases the value of the firm. The company accesses new growth opportunities that will enhance its future business outlook. The positive wealth effects are consistent with the semi-strong form of market efficiency (e.g., Fama (1970) and (1991)). Value-relevant information on the exercise of corporate growth options are promptly translated into stock prices. The market uses this kind of information to update its expectations on the firm's future business outlook.

2. TRADING ACTIVITY

In a first step, we examine the immediate trading behavior around the announcement. The instantaneous stock price reaction to the product introduction announcement is most likely accompanied by a corresponding increase in trading activity. Once the information on the drug approval reaches the market, investors will trade and rebalance their portfolio to incorporate the value-relevant news. Therefore, we analyze the trading activity surrounding the product innovation announcement. Then, we compare the trading activities prior and subsequent to the new product introduction. The exercise of the real option potentially unlocks future growth prospects. The company becomes increasingly valuable to investors which boost trading activity and liquidity of the firm's stock. To study abnormal trading around the event date we employ the methodology used by Chae (2005).

Table 5

Daily Abnormal Turnover around the Product Introduction

This table provides daily abnormal turnover arround the approval decision of the EMEA. An interval of 5 trading days prior and after the decisison is analyzed. t = 0 denotes the day the approval decision was released. Abnormal turnover is defined according to Chae (2005) as the difference between the log turnover and average log turnover estimated from t = -40 to t = -11 with turnover is trading volume over shares outstanding. Means and medians of abnormal turnover are reported. The p Value of a two-sided t-test as well as the q Value of a two-sided sign test are included. ***,**,* denotes significance at the 1%, 5%, and 10% level respectively. Nobs refers to the number of observations for each day. Panel A includes data on the entire sample. The sample of firms is split according to the average market value of equity for a period of 250 trading days prior to the announcement. Panel B comprises firms with an average market value of equity larger than the median market value. Panel C includes the firms with a lower market value of equity than the median market value.

		Days relative to the approval announcement												
t =	-5	-4	-3	-2	-1	0	1	2	3	4	5			
					Pane	el A: All s	ample fi	rms						
Mean	0.072	-0.052	0.057	-0.048	0.036	0.044	0.054	0.143	-0.008	0.149	-0.005			
Median	0.064	-0.088	0.063	-0.082	-0.025	0.024	-0.008	0.076	-0.012	0.061	-0.012			
p Value	0.124	0.362	0.228	0.394	0.429	0.354	0.245	0.006***	0.869	0.004***	0.924			
q Value	0.132	0.068*	0.205	0.098*	0.353	0.738	0.801	0.062*	0.932	0.106	0.932			
Nobs	143	132	140	132	140	143	142	139	138	138	138			
					Panel	B: Large	sample	firms						
Mean	0.040	-0.019	0.071	-0.019	0.033	0.099	0.099	0.086	0.000	0.121	0.000			
Median	0.050	-0.070	0.077	-0.070	-0.020	0.042	0.072	0.056	0.027	0.057	0.027			
p Value	0.474	0.729	0.231	0.729	0.489	0.059*	0.077*	0.160	0.998	0.035**	0.998			
q Value	0.396	0.374	0.268	0.374	0.389	0.182	0.716	0.396	0.708	0.182	0.708			
Nobs	68	62	66	62	66	68	68	68	64	68	64			
					Panel	C: Small	sample	firms						
Mean	0.101	-0.080	0.046	-0.074	0.039	-0.005	0.013	0.199	-0.015	0.176	-0.009			
Median	0.107	-0.139	0.059	-0.139	-0.035	-0.050	-0.103	0.137	-0.028	0.114	-0.028			
p Value	0.171	0.399	0.537	0.438	0.606	0.949	0.861	0.019**	0.852	0.038**	0.914			
q Value	0.248	0.120	0.561	0.188	0.728	0.489	0.416	0.096*	0.561	0.403	0.561			
Nobs	75	70	74	70	74	75	74	71	74	70	74			

Turnover and abnormal turnover are measured as described below:

(4)
$$\log \operatorname{Turnover}(\theta_{i,t}) = \log \frac{\operatorname{Trading Volume}_{i,t}}{\operatorname{Outstanding}_{i,t}}.$$

(5) Abnormal Turnover
$$(\eta_{i,t}) = \theta_{i,t} - \overline{\theta}_i$$
, where $\overline{\theta}_i = \frac{\sum_{t=-40}^{1-1} \theta_{i,t}}{30}$.

Turnover at day *t* for firm *i* is defined as the log of the trading volume (measured in thousands) over the number of outstanding shares. Abnormal turnover is then reported as the difference between the turnover at time *t* and the arithmetic average turnover measure over the preceding 30 trading days. Table 5 reports the results for an 11 trading day period around the new product introduction. We find significant abnormal trading after the new product announcement. Daily turnover increases from 4.4% to 5.4% to 14.3% two days after the product introduction. We split the sample to control for possible size effects. Companies are ranked according to their arithmetic average market value of equity for a 250 trading day period before the event. Large firms are defined as companies with average market value of equity larger than the median market value. Small firms are defined accordingly. Both the small and large firm sample show increased trading activity after the event. However, large firm stocks exhibit abnormal trading activities earlier than small firm stocks. Offsetting trading patterns could be attributable to different coverage intensities for small and large firms. Large firms are exposed to broader media and analyst coverage which can explain the market participants' earlier processing of corporate news.

t = -11

In addition to immediate trading effects we also examine structural, long-term changes in trading patterns before and after the introduction of new products. To analyze changes in trading activity, we employ various measures similar to Denis and Kadlec (1994). First, we compare the average number of stocks traded before and after the new product announcement for the introducing firms. The raw number of issues traded per day is also adjusted for possible price effects. We weigh the number of stock traded per day by the arithmetic average of the current and previous day's closing prices. Then, we derive the percentage of days when actual trades in that particular stock occurred for a period before and after the event. Finally, the pre- and post announcement percentages of stocks available to investors are compared. We evaluate the free float of company stocks prior and subsequent to the new product introduction. Institutional or strategic investors might alter their holdings in firm when the corresponding company exercised growth options. Estimates of the measures employed are derived over a 250 trading day period prior and subsequent to the event of new product introduction. Throughout the study, we keep a 10 day gap around the event date before the estimation period starts. Table 6 reports the results on changes in structural trading patterns.

Table 6

Changes in Trading Activity for the Sample of New Product Introducing Firms

This table provides alternative measures of trading activity for the sample companies with new drug approvals at the EMEA between 1995 and 2009. The trading activity measures are defined similar to Denis and Kadlec (1994): *Number of Stocks* refers to the average number of stocks traded per day in thousands. *Number of value-weighted Stocks* measures the dollar turnover as the value-weighted number of stocks traded per day in thousands. The number of stocks traded per day is multiplied by the average of the days-end closing price and the previous day's closing price. *Pct of Days with Trades* refers to the number of days during the period prior and subsequent to the annoncement for which the company's stock was traded. *Free Float* measures the percentage of free float in outstanding stocks. The measures are averaged over a 250 trading-day period prior and subsequent to the announcement. A 10 day gap surrounding the event is kept to prevent the estimation periods from being biased. Means and medians are listed below. Changes between post- and pre-announcement values are tested for significance using a standard t-test for means and a non-parametric Wilcoxon signed rank test for medians. ***, **, * indicate significance at the 1%, 5% and 10% level respectively.

		Pre-announcement	Post-announcement	Change	t-Statistic z-Statistic	Nobs
Number	Mean	4,326.80	4,743.64	416.84	-2.908 ***	150
of Stocks	Median	2,591.50	2,708.80	117.30	-3.988 ***	150
Number of value-	Mean	144,777.96	160,385.95	15,607.99	-3.532 ***	150
weighted Stocks	Median	98,575.27	123,995.71	25,420.45	-3.901 ***	150
Pct of Days	Mean	0.95	0.94	-0.01	1.118	150
with Trades	Median	0.96	0.96	0.00	-0.041	150
Free Fleet	Mean	75.98	74.53	-1.45	-0.288	86
Free Float	Median	83.49	80.98	-2.51	-1.041	86

New product introductions are associated with an increasing in trading activity. The mean number of stocks traded per day significantly increases from 4,326.8 (median = 2,591.5) before the announcement to 4,743.64 (median = 2,708.8) after the new product is approved. Also, the value-weighted number of

stocks traded per day increases significantly after a new product introduction. Comparing the percentage of days for which trades occurred before and after the event, we cannot find significant changes. Prior to the event, stocks were traded on 95% (median = 96%) of the days during the estimation period. Subsequent to the event, trades were reported on 94% (median = 96%) of the days during the estimation period. Our sample exhibits a high trading frequency already prior to the event. Therefore, a further, event-induced increase in the percentage of days with trades seems unlikely. We also find no significant change in the percentage of shares available at free float before and after the event.

In sum, our sample of new product introductions shows significant abnormal trading activities immediately after the product approval. Value relevant information on the exercise of growth options is transmitted into stock prices and reflected in trading activity. We find some evidence for a size effect. Large firms exhibit abnormal trading earlier than smaller companies. Our sample is also associated with structural, long-term changes in trading patterns. After the event, the daily number of stocks traded increases significantly. A possible explanation for the increase in trades is that company stocks become more liquid after new product introductions. Growth options are exercised and provide a positive signal to outside investors. Therefore, stocks are rendered some of their inherent uncertainty and demand for participating in the firms' future prospects emerges.

3. Systematic Risk Changes

CHANGES IN LEVERAGE

Financial leverage effects systematic risk of common stock (Hamada (1972), Mandelker and Rhee (1984)). We take this potential bias of our systematic risk assessment into account. Table 7 provides summary statistics on corporate leverage ratios before and after the event. Leverage is measured based on both book and market values. Book value of leverage is defined as the ratio of book value of long-term debt to the sum of book value of long-term debt and book value of equity. Pre-announcement book values are derived from balance sheet information of the most recent fiscal year. Post-announcement

book values are calculated from balance sheet items of the subsequent fiscal year. Throughout the analysis we assume a 4 month gap until fiscal year end results are publically available as suggested by Chan et al. (2001). To calculate the market value of leverage, we replace the book value of equity by the average market value of equity estimated over a 250 trading day period before and after the new product initiation.

Table 7

Financial Leverage Changes around New Product Introductions

This table reports the changes in financial leverage for firms with new drug approvals at the EMEA between 1995 and 2009. Financial leverage is measured according to book values as well as market values (Levis et al. (2002)). *Book Value of Leverage* is defined as the ratio of the book value of long-term debt to the sum of the book value of long-term debt and book value of equity. *Market Value of Leverage* is defined as the ratio of the book value of long-term debt to the sum of the book-value of debt and the market value of equity. The market value of equity is measured as the average market value of equity over a period of 250 trading-days prior and subsequent to the announcement. Means and medians are reported below. Pre- and post-announcement book values are derived from company disclosures for the fiscal year prior to the event (pre-announcement) and the fiscal year subsequent to the event (post-announcement). Similar to Chan et al. (2001), a gap of 4 month between fiscal year end and disclosure availability is assumed. The changes between pre- and post-announcement values are tested for significance using a t-test and non-parametric Wilcoxon signed rank test. ***, **, ** denotes significance at the 1%, 5%, and 10% level.

	Book value	e of leverage	Market value of leverage					
	Pre-Announcement	Post-Announcement	Pre-Announcement	Post-Announcement				
Mean	0.251	0.268	0.070	0.072				
Median	0.197	0.198	0.046	0.047				
Change in mean		0.017		0.003				
t-statistics		0.909		-0.628				
Change in median		0.001		0.001				
z-statistic		-2.073 **		-0.216				
Nobs		150		150				

Results on changes in financial leverage are mixed. Weak evidence for an increase in financial leverage is gathered based on book value measures. The median changes from 0.197 to 0.198 around the event. The shift is significant at a 5% level. However, changes in financial leverage are insignificant if compared via a t-test and if measured based on market values of equity.

Table 8

Asset and Equity Betas for New Product Introducing Firms

This table provides estimates of equity and asset betas for firms that recieved a drug approval at the EMEA between 1995 and 2009. Panel A reports equity betas. Equity betas are estimated over a 250 trading-day period prior and subsequent to the announcement day. A 10 day gap is kept around the announcement day to prevent beta estimates from being distorted. Panel B reports asset betas that represent the unlevered equity betas. Betas are unlevered using the market-based debt asset ratio under the assumption that the debt beta is zero. Changes in beta are tested for significance using a t-test and a non-parametric Wilcoxon signed rank test. ***, **, * denotes significance at a 1%, 5%, and 10% level respectively. The entire sample of product approval is split according to size measured as the average market value of equity over a 250 trading day period prior to the event. Large firms include those firms with an average market value in access of the median market value of equity. Small firms include those firms with an average market value is than the median market value of equity.

	Entire Sa	ample	Large	Frims	Small Firms				
	Pre-Announcement	Post-Announcement	Pre-Announcement	Post-Announcement	Pre-Announcement	Post-Announcement			
Panel A: Estimates of	equity betas								
Mean	0.886	0.871	0.847	0.785	0.926	0.957			
Median	0.888	0.848	0.887	0.801	0.948	0.950			
Change in mean		-0.015		-0.062		0.032			
t-statistic		0.537		2.191 **		-0.655			
Change in median		-0.040		-0.086		0.002			
z-statistic		-1.438		-2.419 **		-0.217			
Nobs		150		75		75			
Panel B: Estimates of	asset betas								
Mean	0.823	0.808	0.801	0.739	0.846	0.877			
Median	0.806	0.776	0.814	0.749	0.784	0.880			
Change in mean		-0.015		-0.062		0.031			
t-statistic		0.610		2.275 **		-0.731			
Change in median		-0.030		-0.065		0.097			
z-statistic		-1.286		-2.529 **		-0.507			
Nobs		150		75		75			

MARKET MODEL BETAS

To analyze systematic risk changes around new product introductions, we employ a standard market model as the ex-post variant of the CAPM. Equity betas are estimated over a 250 trading day period before and after the new product introduction. We account for possible biases to changes in financial leverage by unlevering equity betas based on market values. Potential size effects are analyzed by splitting the event sample based on company size. Results for equity and asset betas are reported in table 8. Taking the entire sample into account, we cannot find significant changes in systematic risk after new product introductions. Equity as well as asset beta estimates for the pre- and post-announcement period do not change significantly. However, a size effect is found after splitting the sample by the introducing firm's market value of equity. Large firms exhibit a significant decrease in systematic risk. Mean equity betas are reduced from a pre-announcement level of 0.847 (median = 0.887) to a post-announcement level of 0.785 (median = 0.801). Asset betas are significantly reduced as well. Prior to the announcement, we calculate an average asset beta of 0.739 (median = 0.749). In contrast, small firms' systematic risk changes are insignificant. For both equity and asset betas we cannot find evidence for significant systematic risk changes.

To sum, we find a significant size effect based on market model beta estimates. Large firm exhibit a significant decrease in systematic risk after exercising their growth options. The systematic risk for small firms, however, is invariant to new product introductions and the exercise of real options.

ADJUSTED BETAS

Changes in the accuracy of return measurement or differences in the speed of price adjustment causes market model beta estimates to be biased. If stocks are subject to liquidity changes, stock return might respond to new information differently for that particular period. Price adjustments take longer for periods of less liquid trading. Consequently, betas measuring the responsiveness of stock returns to market returns represent inadequately the return sensitivity for periods with structural trading pattern changes. Scholes and Williams (1977), Dimson (1979), and Cohen et al. (1980) show that beta estimates are upwardly biased for stock that are frequently traded in contrast to infrequently traded stock that are downwardly biased. Nonsynchronous trading as well as friction in the trading process can cause price adjustment delays. As a result, stock returns exhibit serial correlation which leads to biased beta estimates (Cohen et al. (1983)). Hence, changes in trading patterns influence return measurement and need to be accounted for when studying systematic risk changes (see Denis and Kadlec (1994) for further discussions).

The above analysis of trading activity reveals significant changes in trading patterns around new product introductions. Given the changes in market micro structure, market model based betas estimates as reported in table 8 are potentially biased. We therefore implement the methodology proposed by Cohen et al. (1983) to check the robustness of our above results. Cohen et al. (1983) develop a procedure that corrects market model beta parameters for frictions in the trading process. They address the intervalling-effect bias and frictions caused by price-adjustment delays. The authors generalize the work seminal work of Scholes and Williams (1977). Their beta estimate includes a generalized lead-lag structure of periodical returns and adjusts for price delays of more than one day.

Table 9 provides the beta estimates based on Cohen et al. (1983) which we further refer to as "Cohen betas". Cohen betas are estimated over a 250 trading day period before and after the new product introduction. We estimate Cohen betas with up to 5 lead and 5 lags. With that, a period of two trading weeks is covered. Further leads and lags are not included given the inherent loss of efficiency. A symmetric leads and lags structure is used to avoid the impression of data mining (Denis and Kadlec (1994)). We cannot find significant changes in systematic risk for the entire lead-lag structure employed. We also cannot find evidence for a potential size effect as suggested above. After splitting the sample according to market value of equity, we cannot find systematic risk changes for both small and large companies.

This result suggest that the above mentioned reduction in beta based on regular market model estimation is due to changes in trading patterns rather than a structural change in systematic risk. Once corrective estimation techniques are used, systematic risk appears invariant to exercises in growth options and new product introductions.

We explore our results further and take changes in leverage into account. Table 10 reports the unlevered Cohen betas prior and subsequent to the event. We unlever Cohen betas using market values of equity as well as book values of equity. Unlevering Cohen betas reduces the overall level of beta. But again, we cannot find significant changes in systematic risk before and after new product introductions. Panel A reporting market-value based Cohen betas as well as Panel B reporting book-value based Cohen betas show no significant changes in systematic risk prior and subsequent to new product initiations. The sample is also split according to size. However, we find no evidence on potential size effects. Changes in systematic risk are neither important for small firms nor for large firms.

To sum our results, we cannot find evidence on systematic risk changes around new product introductions. Once controlled for potential biases in beta estimation associated with trading frictions and price adjustment delays, beta changes appear statistically insignificant. Results are supported also after controlling for leverage effects. Hence, our findings suggest that new product introductions have no influence on systematic risk of the announcing firm. Consequently, neither outside investor's return expectations should be adjusted nor should the firm alter its cost of capital.

Table 9

Cohen Betas for the Samples of New Product-Introducing Firms

This table provides alternative estimates of pre-announcement and post-announcement systematic risk (beta) for the sample of 150 firms that received a positive opinion by the EMEA for their application of new drug candidates over the period 1994 to 2009. Pre-announcement betas are estimated over a 250 trading-day period preceeding the EMEA decision, while post-announcement betas are derived over the 250 trading-day period subsequent to the announcement. A 10 day gap around the announcement day is kept to prevent the beta estimates from being distorted by any event-induced effects. Beta estimates are derived using the technique detailed in Cohen et al. (1983). The analysis includes lead and lagged coefficients up to 5 trading days. The significance of changes in betas are measured using standard t-tests for means and Wilcoxon signed rank tests for medians. Panel A reports the result for the entire company sample. The sample is further split by the median of equity market value measured over a 250 trading-day period before the event. Panel B includes announcing firms with average market values of equity larger than the median market value.

			Panel A: All sample	firms				Panel B: Large	firms			Panel C: Small firms				
		Pre-Announcement	cement Post-Announcement Change		t-Statistic	Nobe	Pre-Announcement	Post-	Chango	t-Statistic	Nobr	Pre-Announcement	Post-	Chango	t-Statistic	Nobr
		Period	Period	Change	z-value	NUDS	Period	Announcement	Change	z-value	NUDS	Period	Announcement	Change	z-value	NODS
Daily	Mean	0.878	0.874	-0.003	0.088	150	0.833	0.792	-0.041	0.876	75	0.923	0.957	0.034	-0.549	75
(1 lead, 1 lag)	Median	0.873	0.820	-0.053	-0.012	150	0.855	0.772	-0.083	-1.230	75	0.948	0.897	-0.051	-0.919	75
Daily	Mean	0.864	0.865	0.001	-0.031	150	0.804	0.742	-0.062	1.105	75	0.923	0.988	0.065	-0.979	75
(2 leads, 2 lags)	Median	0.864	0.814	-0.050	-0.008	150	0.856	0.769	-0.087	-0.956	75	0.936	0.845	-0.090	-0.861	75
Daily	Mean	0.816	0.840	0.024	-0.534	150	0.727	0.713	-0.014	0.240	75	0.904	0.966	0.062	-0.926	75
(3 leads, 3 lags)	Median	0.788	0.758	-0.029	-1.048	150	0.711	0.687	-0.024	-0.491	75	0.880	0.899	0.019	-1.014	75
Daily	Mean	0.813	0.815	0.002	-0.050	150	0.715	0.723	0.008	-0.142	75	0.911	0.908	-0.003	0.036	75
(4 leads, 4 lags)	Median	0.781	0.750	-0.031	-0.149	150	0.699	0.685	-0.014	-0.412	75	0.882	0.858	-0.024	-0.137	75
Daily	Mean	0.848	0.834	-0.014	-0.413	150	0.746	0.747	0.002	-0.028	75	0.951	0.921	-0.030	0.301	75
(5 leads, 5 lags)	Median	0.795	0.782	-0.014	-0.560	150	0.748	0.745	-0.003	-0.581	75	0.846	0.829	-0.017	-0.259	75

Table 10

Unlevered Cohen Betas for the Samples of New Product-Introducing Firms

Unlevered Cohen Betas for the Samples of New Product-Introducing Firms

This table provides alternative estimates of pre-announcement and post-announcement systematic risk (beta) for the sample of 150 firms that received a positive opinion by the EMEA for their application of new drug candidates over the period 1995 to 2009. Preannouncement betas are estimated over a 250 trading-day period preceeding the EMEA decision, while post-announcement betas are derived over the 250 trading-day period subsequent to the announcement. A 10 day gap around the announcement day is kept to prevent the beta estimates from being distorted by any event-induced effects. Beta estimates are derived using the technique detailed in Cohen et al. (1983). The analysis includes lead nd lagged coefficients up to 5 trading days. Betas are unlevered using the marketbased debt asset ratio under the maintained assumption that debt beta is zero as well as book-value based asset ratios. Means and medians are listed below. The significance of changes in betas are measured using standard t-tests for means and Wilcoxon signed rank tests for medians. Panel A reports the unlevered Cohen betas based on book values. The sample is further split by the median of equity market values while Panel B summarized unleverd Cohen betas based on book values. The sample is further split by the median of equity market values were a 250 trading-day period before the event. Large firms include announcing companies with average market values of equity larger than the median market value. Small firms include announcing companies with average market values.

			All sample firr	ns				Large firr	ns				Small firms				
		Pre-Announcement	Post-Announcement	Change	t-Statistic	Pro Pro	e-Announcement	Post-	Change	t-Statistic	Naha	Pre-Announcement	Post-	Change	t-Statistic	Naha	
		Period	Period	Change	z-value	NODS	Period	Announcement	Change	z-value	NODS	Period	Announcement	Change	z-value	NODS	
Panel A: Unlevered	l Cohen Bet	as based on Market V	alues														
Daily	Mean	0.813	0.811	-0.002	0.059	150	0.787	0.746	-0.041	0.917	75	0.839	0.876	0.036	-0.645	75	
(1 lead, 1 lag)	Median	0.801	0.771	-0.030	-0.020	150	0.789	0.741	-0.048	-1.236	75	0.844	0.852	0.008	-0.919	75	
Daily	Mean	0.798	0.798	-0.001	0.022	150	0.758	0.701	-0.057	1.084	75	0.839	0.894	0.055	-0.890	75	
(2 leads, 2 lags)	Median	0.796	0.751	-0.045	-0.050	150	0.760	0.735	-0.025	-0.914	75	0.863	0.812	-0.051	-0.808	75	
Daily	Mean	0.754	0.772	0.019	-0.437	150	0.684	0.669	-0.015	0.256	75	0.823	0.875	0.052	-0.825	75	
(3 leads, 3 lags)	Median	0.719	0.694	-0.024	-1.067	150	0.682	0.651	-0.031	-0.533	75	0.826	0.804	-0.021	-1.019	75	
Daily	Mean	0.749	0.752	0.003	-0.064	150	0.674	0.679	0.005	-0.094	75	0.824	0.825	0.001	-0.013	75	
(4 leads, 4 lags)	Median	0.689	0.701	0.012	-0.245	150	0.660	0.624	-0.036	-0.370	75	0.820	0.789	-0.031	-0.037	75	
Daily	Mean	0.783	0.772	-0.011	0.210	150	0.701	0.700	0.000	0.006	75	0.865	0.843	-0.021	0.245	75	
(5 leads, 5 lags)	Median	0.711	0.730	0.019	-0.616	150	0.683	0.729	0.046	-0.549	75	0.786	0.730	-0.056	-0.296	75	
Panel B: Unlevered	l Cohen Bet	as based on Book Valu	ies														
Daily	Mean	0.632	0.619	-0.014	0.410	150	0.651	0.626	-0.026	0.671	75	0.614	0.612	-0.002	0.037	75	
(1 lead, 1 lag)	Median	0.651	0.602	-0.049	-0.014	150	0.651	0.593	-0.057	-0.813	75	0.650	0.621	-0.030	-0.581	75	
Daily	Mean	0.622	0.569	-0.053	1.108	150	0.626	0.589	-0.037	0.830	75	0.617	0.549	-0.068	0.810	75	
(2 leads, 2 lags)	Median	0.621	0.591	-0.030	-0.457	150	0.606	0.557	-0.049	-0.502	75	0.671	0.621	-0.051	-0.153	75	
Daily	Mean	0.579	0.534	-0.045	0.877	150	0.561	0.556	-0.006	0.116	75	0.597	0.512	-0.085	0.939	75	
(3 leads, 3 lags)	Median	0.543	0.522	-0.021	-0.755	150	0.521	0.505	-0.016	-0.840	75	0.622	0.581	-0.041	-0.222	75	
Daily	Mean	0.582	0.528	-0.054	1.110	150	0.557	0.565	0.008	-0.166	75	0.608	0.491	-0.116	1.354	75	
(4 leads, 4 lags)	Median	0.537	0.526	-0.011	-0.091	150	0.480	0.516	0.036	-0.523	75	0.571	0.568	-0.003	-0.655	75	
Daily	Mean	0.604	0.583	-0.021	0.478	150	0.575	0.582	0.007	-0.155	75	0.633	0.583	-0.050	0.664	75	
(5 leads, 5 lags)	Median	0.560	0.569	0.009	-0.547	150	0.509	0.563	0.054	-0.771	75	0.589	0.580	-0.009	-0.095	75	

V. IMPLICATIONS AND CONCLUSIONS

Systematic risk, as crucial parameter in the CAPM, determines the required return to equity investors and thereby impacts the firm's capital budgeting (e.g., Bruner (1998) and Graham and Harvey (2001)). Changes in the firm's systematic risk influence the overall cost of capital and the company's investment policy and should therefore be of concern to corporate managers. Several variables and their influence on systematic risk have been analyzed (e.g., Beaver et al. 1970), Hamada (1972), Mandelker and Rhee (1984), Ismail and Kim (1989)). However, evidence is scarce on the impact of new product introductions on systematic risk despite the steady shift towards a knowledge- and innovation-based economy (Grossman and Helpman, 1995). Moreover, existing rudimental findings are questionable since previous studies employ a limited focus or do not take potential biases in estimating systematic risk into account. Our study closes this gap and examines the relationship between new product introductions and associated changes in systematic risk. The marginal effects of new product releases is placed within a real option framework in which we regard the product introduction as exercise of firm's growth options.

To do so, we use a unique hand-collected data set of new product approvals in the pharmaceutical industry. We explicitly test our results for robustness by accounting for leverage-induced risk changes and biases related to frictional trading (Hamada (1972) and Cohen et al. (1983)). Therefore, our analysis provides more thorough empirical evidence on financial consequence of real option exercises and consequences for the firm's systematic risk and cost of capital.

Results show a significant wealth effect associated with new product introductions. We find abnormal stock price reactions of 1.08% around the announcement. Positive wealth effects are associated with abnormal trading activity around the product introductions. Share turnover increases significantly after the announcement. Trading activity for large firms' stocks increases earlier than for small firms' stocks. We explain the size effect by more intensive news coverage and greater investor awareness for large companies. In addition, we find a structural change in trading patterns. Shares of new product introduction ing companies are traded heavier after the product release. The average daily number of stock traded

increases significantly after the event. We interpret this finding as evidence for increased liquidity in the stock for the announcing firm. In analyzing the effects on systematic risk, we first estimate systematic risk with a standard market model for comparison to previous works. We find weak evidence of a decrease in systematic risk after new product introductions. However, once controlled for frictional trading and leverage changes evidence vanishes and we do not confirm a risk reduction. Systematic risk changes as reported previously (e.g., Devinney 1992) are caused by statistical flaw rather than a structural change in the firm risk characteristics.

The results suggest that outside investors do not adjust their return requirements by accounting for different levels of firm risk before and after the new product introduction. We conclude that the exercise of real options – proxied via new product introductions – might influence the likelihood of receiving future cashflows for the firm. However, the sensitivity of such cashflows to overall market movements – as measured by the firm's inherent systematic risk – remains unchanged. Consequently, managers should not mistake a successful new product release with lower cost of capital.

VI. REFERENCES

- Amihud, Y. (2002): Illiquidity and stock returns: Cross-section and time-series effects, in: *Journal of Financial Market*, 5, 31 56.
- Antweiler, W.; Frank, M. Z. (2006): Do U.S. Stock Markets Typically Overreact to Corporate News Stories? Working Paper, Sauder School of Business, University of British Columbia, Vancouver.
- Beaver, W.; Kettler, P.; Scholes, M. (1970): The Association Between Market Determined and Accounting Determined Risk Measures, in: Accounting Review, 654 682.
- Berk, J. B.; Green, C. G.; Naik, V. (1999): Optimal Investment, Growth Options, and Security Returns, in: Journal of Finance, 54, 1553 – 1607.
- Bernardo, A. E.; Chowdhry, B.; Goyal, A. (2007): Growth Options, Beta, and the Cost of Capital, in: *Financial Management*, 5 – 17.
- Boehmer, E.; Musumeci, J.; Poulsen, A. B. (1991): Event-study methodology under conditions of eventinduced variance, in: *Journal of Financial Economics*, 30 (2), 253 – 272.
- Brown, S. J.; Warner, J. B. (1985): Using daily stock Returns The case of event studies, in: *Journal of Financial Economics*, 14 (1), 3 31.
- Bruner, F. R.; Eades, K. M.; Harris, R. S.; Higgins, R. C. (1998): Best Practice in Estimating the Cost of Capital: Survey and Synthesis, in: *Financial Practice and Education*, 8, 13 – 28.
- Chae, J. (2005): Trading Volume, Information Asymmetry, and Timing Information, in: *Journal of Finance*, 60 (1), 413 442.
- Chan, L. K., Lakonishok, J. and Sougiannis, T. (2001): The Stock Market Valuation of Research and Development Expenditures, in: *Journal of Finance*, 55 (6), 2431 – 2456.
- Chung, K. H.; Charoenwang, C. (1991): Investment Options, Assets in Place, and the Risk of Stocks, in: *Financial Management*, 21 – 33.
- Cohen, K. J.; Hawawini, G. A.; Maier, S. F.; Schwartz, R. A.; Whitcomb, D. K. (1983): Friction in the Trading Process and the Estimation of Systematic Risk, in: *Journal of Financial Economics*, 12, 263 – 278.

- Cohen, K. J.; Hawawini, G. A.; Maier, S.; Schwartz, R. A.; Whitcomb, D. K. (1980): Implications of microstructure theory for empirical research on stock price behavior, in: *Journal of Finance*, 35, 249 – 257.
- Denis, D. J.; Kadlec, G. B. (1994): Corporate Events, Trading Activity, and the Estimation of Systematic Risk: Evidence form Equity Offerings and Share Repurchses, in: *Journal of Finance*, 49 (5), 1787 – 1811.
- Devinney, T. M. (1991): New Products and Financial Risk Changes, in: *Journal of Product Innovation Management*, 9, 222 231.
- Dimson, E. (1979): Risk measurement when shares are subject to infrequent trading, in: *Journal of Financial Economics*, 7, 197 – 226.
- Dimson, E. (1979): Risk Measurement when Shares are Subject to Infrequent Trading, in: *Journal of Financial Economics*, 7, 197 226.
- Fama, E. (1970): Efficient Capital Markets: A Review of Theory and Empirical Work, in: *Journal of Finance*, 25, 383 417.
- Fama, E. (1991): Efficient Capital Markets: II, in: Journal of Finance, 46 (5), 1575 1617.
- Fama, E.; French, K. R. (1992): The Cross-Section of Expected Stock Returns. *Journal of Finance* 47 (2), 427 465.
- Garattini, S.; Bertele, V. (2004): The Role of the EMEA in Regulating Pharmaceutical Products, in: Regulating Pharmaceuticals in Europe: Striving for Efficiency, Equity and Quality; Chapter 4, (Mossialos, E.; Mrazek, M.; Walley, T.); Open University Press.
- Graham, J. R.; Harvey, C. R. (2001): The Theory and Practice of Corporate Finance: Evidence from the Field, in: *Journal of Financial Economics*, 60, 187 243.
- Grossman, G. M.; Helpman, E. (1995): Innovation and Growth in the Global Economy, Cambridge, MIT Press.

- Hamada, R. S. (1972): The Effects of the Firm's Capital Structure on the Systematic Risk of Common Stocks, in: *Journal of Finance*, 27, 435 452.
- Ismail, B. E.; Kim, M. K. (1989): On the Association of Cash Flow Variables with Market Risk: Further Evidence, in: *Accounting Review*, 64 (1), 125 – 136.
- Jacquier, E.; Titman, S.; Yalcin, A. (2009): Growth Opportunities and Assets in Place: Implications for Equity Betas, Working Paper, HEC Montreal Finance Department.
- Jägle, A. J. (1999): Shareholder value, real options, and innovation in technology-intensive companies, in: *R&D Management*, 29 (3), 271 287.
- Kothari, S.P.; Warner, J. B. (2007): Econometrics of Event Studies, in: Handbook of Corporate Finance Empirical Corporate Finance Vol. 1, Eckbo, E. B. (edt.). New York: North-Holland.
- Lewis, C. M.; Rogalski, R.; Seward, J. K. (2002): Risk Changes around Convertible Debt Offerings, in: *Journal of Finance*, 8, 67 – 80.
- Lintner, J. (1965): The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets, *Review of Economics and Statistics*, 47, 13 – 37.
- Mac Kinley, C. A. (1997): Event Studies in Economics and Finance, in: *Journal of Economic Literature*, 35 (1), 13 39.
- Mandelker, G. N.; Rhee, G. S. (1984): The impact of the Degree of Operating and Financial Leverage on Systematic Risk of Common Stocks, in: *Journal of Financial and Quantitative Analysis*, 19 (1), 45 – 57.
- McAlister, L.; Srinivasan, R.; Kim, M. (2007): Advertising, Research and Development, and Systematic Risk of the Firm, in: *Journal of Marketing*, 71, 35 48.
- Mossin, J. (1966): Equilibrium in Capital Asset Market, in: *Econometrica*, 34 (4), 768 783.
- Myers, S. (1977): Determinants of Corporate Borrowing, in: Journal of Financial Economics, 5, 147 175.
- Scholes, M.; Williams, J. (1977): Estimating betas from nonsynchronous data, in: *Journal of Financial Economics*, 5, 309 – 327.

Sharpe, W. F. (1964): Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk, in: Journal of Finance, 19, 425 – 442.