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# Stock price responses on the German suspension of genetically modified maize

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## Abstract

This note investigates the effect of the German governments' decision to suspend the cultivation of genetically modified maize on the stock returns of involved companies. Moreover, the first announcement to investigate a ban as well as a court decision rejecting Monsanto's lawsuit against the suspension are considered. This study is motivated by the expectation that these decisions have consequences beyond the small German market for genetically modified maize. An event study is used to evaluate the economic impacts on stock returns of Monsanto, Bayer and BASF. We find slight evidence that stock prices of Monsanto and BASF responded negatively to the German suspension of genetically modified maize.

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## 1. Introduction

Genetically modified (GM) crops are a major success story in agricultural research, with an area of 134 million hectares worldwide under biotech crops in 2009 (James, 2010). In Europe, the only GM crop currently planted commercially is Bt maize. Bt plants are made resistant against insect pests (in case of maize the corn borer) by incorporating a gene from the *Bacillus thuringiensis* (Bt) bacterium. Due to the plants pest resistance, significant reductions of yield losses (i.e. higher average yields) and cost reductions (reduced application rates of pesticides) could be achieved in regions where pest pressure is a problem for farmers (Gómez-Barbero et al., 2008). The adoption rates of Bt maize in European countries (except for Spain) are small, among other reasons, due to small pest pressure, high regulation costs for co-existence with conventional crops and the non-acceptance by consumers. However, introducing (one or more) GM traits in other crops that might be more important for Europe, such as potato or sugar beet, is promising (e.g. Flannery et al., 2004) and thus will constitute a considerable market for the future.

In Germany, 3180 hectares have been under Bt maize in 2008, representing only 0.15% of the national maize acreage (Consmüller et al., 2009). The Bt maize cropped in Germany contained the MON810 trait provided by Monsanto, the leading world market producer of genetically modified seeds. In April 14, 2009, the Federal Office of Consumer Protection and Food Safety of the German government suspended the cultivation of maize varieties that contain the MON810 trait, based on study results showing that Bt maize might be a hazard for human health and the environment. Germany was the sixth European country banning Bt maize, besides France, Hungary, Greece, Luxembourg and Austria (see Sinha, 2009, for an overview). The German decision was based on selected individual studies, and is claimed to have ignored the scientific evidence from the vast majority of publications on the potential hazards of Bt maize (see Ricroch et al., 2010, for a discussion). These and other decisions with respect to genetically modified crops in Germany and other European countries seem to be rather determined by processes in policy, activist groups and the media than by scientific foundations (e.g. Sinha, 2009, James, 2010).

In this respect, this (political) decision of the German government might have had a negative influence on Germany's leading role as a location for research and science, particularly for the further development of crop science research. In addition, the German decision might have been

a signal for other countries, making it to a forerunner for political decisions for banning GM crops. Thus, even though the size of the market for Bt maize in Germany was negligible, the decision of the German government is expected to have an effect on the value of the firms involved in agricultural biotechnology research and development. Besides the actual announcement of the ban on April 14, 2009 (e.g. Gross, 2009), we expect the May 5, 2009 to be potentially important, where a German court rejected Monsanto's attempt to suspend the ban on MON810 (Sinha, 2009). Moreover, we consider the February 18, 2009, because at this date, the German Federal Minister of Food, Agriculture and Consumer Protection (Ilse Aigner) made the first announcement (in a newspaper interview) to investigate a ban of MON810 (Berliner Zeitung, 2009).

In this note, we test if these three events had an influence on stock prices of 3 companies: Monsanto (the owner of the banned MON810 trait), Bayer (Germany based chemical and pharmaceutical company and one of the world's leading crop science companies, with its subsidiary Bayer CropScience being involved in the development of genetically modified crops) and BASF (a Germany based chemical company which is involved in the development of genetically modified crops with its subsidiary BASF Plant Science). Though Bayer and BASF are not directly affected by the ban of MON810, they operate in the market of genetically modified crop development, have their headquarters and parts of their market operations in Germany, and finally have joint projects with Monsanto. In order to test the influence, we use a standard event study methodology.

## 2. Methodology

The event study methodology is a useful tool to evaluate the economic impact of a single event, assuming that these effects will be reflected in security prices (e.g. Leeds, 2009, MacKinlay, 1997, Takeda and Tomozawa, 2006). We calculate daily (day *t*) stock returns ($r_{it}$) of company *i* using the percentage change[1] between the closing prices at day *t-1* and *t*. In order to account for the development of a broader market index, we included the daily returns ($r_t^I$) of the S&P 500 (for Monsanto) and the DAX (for Bayer and BASF). Effects of a specific event are estimated

[1] We also considered the percentage change between the opening and closing price at day *t*, which led to similar results as the here presented.

with abnormal returns, i.e. the deviations of actual stock returns from their expected returns (based on the performance of the broader market index). The impact of the event is analyzed by using an event window, including a period before (period $T_1$) and after (period $T_2$) the day of the event under study ($T_A$). Following Leeds (2009), we specify the event study model as follows:

$$r_{ti} = \beta_0 + \beta_1 r_t^I + \sum_{S=T_A-T_1}^{T_A+T_2} \delta_S D_S + \varepsilon_t$$

In this model, $\beta_1$ captures the relationship between the stock return of company *i* and its broader market index, $\varepsilon_t$ is a random error term, and $D_S$ is a dummy for a specific day within the event window that lasts $T_1 + T_2 + 1$ days. $\delta_S$ is an estimate for the abnormal return on a specific day. In order to estimate the abnormal returns within the entire event window, the cumulative abnormal returns (CAR) are calculated as the sum of all estimates for abnormal returns: $CAR = \sum_{S=T_A-T_1}^{T_A+T_2} \hat{\delta}_S$ .

In order to test if the CARs are significantly different from zero, we construct 90% confidence intervals of the sums of abnormal returns (90% CI) using non-parametric bootstrap using 1000 bootstrap samples (see Wilcox, 2005, for details).

As outlined above, three events ($T_A$) are considered: a) February 18, 2009, b) April 14, 2009 and c) May 5, 2009. The estimation window used starts at April 1, 2008. We use two different lengths of event windows to account for the impact of different lengths on the results: a) $T_1 = T_2 = 10$ and b) $T_1 = T_2 = 5$. Daily stock prices for Monsanto, Bayer, BASF, S&P 500 and the DAX that are used for the estimation are taken from the *Yahoo!* website.

## 3. Results

Tables 1, 2 and 3 show the estimation results for the three events, i.e. the first announcement of investigations to ban MON810 (February 18, 2009), the actual ban of MON810 by the German government (April 14, 2009), and the rejection of Monsanto's attempt to suspend the ban on MON810 by a German court (May 05, 2009), respectively. Because the two considered lengths of event windows (+/- 5 and 10 days) led to similar results with respect to coefficient signs and

levels of significance, only results for the event window $T_1 = T_2 = 10$ are presented. It shows that the coefficient estimates for $\beta_1$, i.e. for the influence of the broader market index, are significant for all companies. Thus, all companies track very closely with the overall indexes considered. Note that the rather low goodness of fit values indicate that also other determinants than the here considered played a substantial role for stock price development within the considered event windows.

With four exceptions, all dummy variables (for abnormal returns at a specific day) are not significant at the 10% level. More specifically, no significant abnormal returns are found for the three event days. However, we find significant (at the 10% level) overall effects (indicated by the confidence intervals of cumulative abnormal returns) for Monsanto and BASF at event 1. Thus, the announcement of the German Federal Minister of Food, Agriculture and Consumer Protection to investigate the ban of MON810 led to a slightly worse performance of Monsanto and BASF stocks than their broader market indexes in the considered event window.

In contrast, the actual announcement of the ban on April 14, 2009 did not lead to negative cumulative abnormal returns (except for BASF). We expect that the negative reaction of the market to the potential ban was already included in stock returns (i.e. was integrated in market expectations) after the announcement of investigations (event 1). Thus, the actual ban of MON810 on April 14, 2009, was already expected by the stock market. Moreover, Monsanto filed suit against the German government's decision to ban genetically modified maize some days after the ban (Reuters, 2009), which might have induced some positive market responses.

The effects of the rejection of Monsanto's attempt to suspend the ban on MON810 on May 05, 2009 (event 3) results in negative (but insignificant) cumulative abnormal returns for Monsanto and BASF. Thus, the rejection of Monsanto's attempt to suspend the ban on MON810 had a slightly negative impact on stock returns. Interestingly, negative cumulative abnormal returns for all 3 events were found for BASF (in case of Monsanto for 2 events), while stock price responses of Bayer have been positive for these events. Thus, market expectations for BASF and Monsanto were more affected by the German suspension of genetically modified maize than for Bayer. In particular for BASF, the suspension of MON810 might have revealed (further) expected problems with the cultivation of their own developed genetically modified crops, such as the potato Amflora, on the German and European market.

A possible explanation that no strong (i.e. highly significant) effects have been found for the three events might be an expected short duration of the ban (i.e. no long-lasting effect), based on the controversial discussion with regard to this issue in the German government (e.g. Gross, 2009) as well as the strong position of the European Food Safety Authority (the EU's body for risk assessment regarding food and feed safety) who clearly allows the cultivation of MON810.

In conclusion, we find slight evidence that stock prices of Monsanto and BASF responded negatively to the German suspension of genetically modified maize (or more specifically, the first announcement to investigate a ban of MON810), while no effects have been found for the stock prices of Bayer. Due to the size of the current and potential future market for genetically modified crops, further research should address the economic impacts of excessive regulations in this field (Potrykus, 2010), such as on firm performance and food production.

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**Table 1. Estimation results for event 1 (February 18, 2009): German Federal Minister of Food, Agriculture and Consumer Protection announced to investigate a ban of MON810.**

| Variable | Coefficient (t-ratio) | | |
|---|---|---|---|
| | **Monsanto** | **Bayer** | **BASF** |
| **Market index**[1] | 0.9758 (13.36)*** | 0.7180 (12.82)*** | 1.0696 (8.63)*** |
| **-10**[2] | -0.0355 (-1.11) | 0.0286 (1.31) | -0.0486 (-1.01) |
| **-9** | -0.0247 (-0.78) | -0.0025 (-0.11) | 0.0097 (0.20) |
| **-8** | 0.0064 (0.20) | -0.0086 (-0.39) | -0.0519 (-1.10) |
| **-7** | 0.0051 (0.16) | 0.0083 (0.38) | -0.0053 (-0.11) |
| **-6** | -0.0149 (-0.46) | -0.0114 (-0.52) | 0.0087 (0.18) |
| **-5** | 0.0168 (0.53) | -0.0121 (-0.56) | 0.0051 (0.11) |
| **-4** | -0.0059 (-0.19) | -0.0121 (-0.07) | 0.0047 (0.10) |
| **-3** | 0.0070 (0.22) | -0.0003 (-0.02) | -0.0235 (-0.49) |
| **-2** | -0.0041 (-0.13) | -0.0068 (-0.31) | 0.0046 (0.09) |
| **-1** | -0.0137 (-0.43) | -0.0123 (-0.57) | -0.0048 (-0.10) |
| **Day 0 (Minister announces investigation)** | -0.0332 (-1.04) | 0.0021 (0.01) | 0.0112 (0.23) |
| **1** | -0.0213 (-0.67) | 0.0013 (0.06) | -0.0020 (-0.04) |
| **2** | 0.0302 (0.94) | -0.0118 (-0.54) | -0.0108 (-0.22) |
| **3** | 0.0030 (0.09) | 0.0179 (0.82) | -0.0268 (-0.56) |
| **4** | 0.0058 (0.18) | 0.0020 (0.09) | 0.0135 (0.28) |
| **5** | -0.0212 (-0.66) | 0.0399 (1.83)* | -0.0477 (-0.99) |
| **6** | -0.0188 (-0.59) | -0.0051 (-0.23) | -0.0007 (-0.02) |
| **7** | 0.0146 (0.46) | 0.0116 (0.53) | 0.0042 (0.09) |
| **8** | -0.0098 (-0.31) | 0.0043 (0.20) | 0.0047 (0.10) |
| **9** | -0.0013 (-0.04) | 0.0040 (0.18) | -0.0184 (-0.38) |
| **10** | -0.0183 (-0.57) | 0.0168 (0.77) | 0.0091 (0.19) |
| **Constant** | -0.0001 (-0.05) | -0.0001 (-0.08) | 0.0031 (1.07) |
| **CAR** | -0.1339 | 0.0645 | -0.1650 |
| **[90% CI of CAR]** [3] | [-0.2626, -0.0074]* | [-0.0304, 0.1668] | [-0.3188, -0.0165]* |
| **Adj $R^2$** | 0.39 | 0.37 | 0.20 |

1) S&P 500 is used as market index for Monsanto, the DAX is used for Bayer and BASF. 2) '-10' denotes 10 days before the event date. 3) 90% confidence intervals (90% CI) of CARs are constructed using non-parametric bootstrap. *, **, and *** denote significance at the 10, 5 and 1% level, respectively.

**Table 2. Estimation results for event 2 (April 14, 2009): German government announces ban of MON810.**

| Variable | Coefficient (t-ratio) | | |
|---|---|---|---|
| | **Monsanto** | **Bayer** | **BASF** |
| **Market index**[1] | 0.9822 (13.59)*** | 0.7399 (13.11)*** | 1.0845 (8.53)*** |
| **-10**[2] | 0.0097 (0.30) | -0.0039 (-0.18) | 0.0075 (0.15) |
| **-9** | 0.0336 (1.05) | 0.0245 (1.12) | -0.0019 (-0.04) |
| **-8** | 0.0328 (1.02) | 0.0137 (0.63) | -0.0036 (-0.07) |
| **-7** | 0.0123 (0.39) | 0.0151 (0.68) | -0.0123 (-0.25) |
| **-6** | 0.0193 (0.60) | 0.0096 (0.44) | -0.0469 (-0.95) |
| **-5** | -0.0062 (-0.19) | -0.0173 (-0.79) | -0.0014 (-0.03) |
| **-4** | -0.0175 (-0.55) | -0.0059 (-0.27) | 0.0089 (0.18) |
| **-3** | 0.0057 (0.18) | 0.0086 (0.39) | 0.0045 (0.09) |
| **-2** | 0.0002 (0.01) | 0.0038 (0.17) | -0.0338 (-0.68) |
| **-1** | -0.0005 (-0.02) | 0.0173 (0.79) | -0.0177 (-0.36) |
| **Day 0 (MON810 ban announced)** | 0.0039 (0.12) | -0.0141 (-0.65) | 0.0130 (0.26) |
| **1** | 0.0294 (0.92) | -0.0011 (-0.05) | 0.0169 (0.34) |
| **2** | 0.0078 (0.24) | 0.0121 (0.55) | 0.0100 (0.20) |
| **3** | -0.0088 (-0.27) | -0.0257 (-1.17) | -0.0076 (-0.15) |
| **4** | 0.0078 (0.24) | -0.0200 (-0.92) | 0.0083 (0.17) |
| **5** | -0.0017 (-0.05) | 0.0072 (0.33) | -0.0055 (-0.11) |
| **6** | 0.0007 (0.02) | 0.0036 (0.16) | 0.0107 (0.22) |
| **7** | 0.0006 (0.02) | 0.0163 (0.74) | -0.0217 (-0.44) |
| **8** | -0.0255 (-0.80) | 0.0045 (0.21) | -0.0052 (-0.11) |
| **9** | 0.0020 (0.06) | -0.0075 (-0.34) | -0.0052 (-0.11) |
| **10** | -0.0094 (-0.29) | 0.0487 (2.22)** | 0.0273 (0.55) |
| **Constant** | -0.0010 (-0.47) | -0.0001 (-0.06) | 0.0031 (1.01) |
| **CAR** | 0.0962 | 0.0892 | -0.0560 |
| **[90% CI of CAR]**[3] | [-0.0149, 0.2160] | [-0.0308, 0.2108] | [-0.1827, 0.0723] |
| **Adj $R^2$** | 0.38 | 0.37 | 0.18 |

1) S&P 500 is used as market index for Monsanto, the DAX is used for Bayer and BASF. 2) '-10' denotes 10 days before the event date. 3) 90% confidence intervals (90% CI) of CARs are constructed using non-parametric bootstrap. *, **, and *** denote significance at the 10, 5 and 1% level, respectively.

**Table 3. Estimation results for event 3 (May 05, 2009): German court rejects Monsanto's attempt to suspend the ban on MON810.**

| Variable | Coefficient (t-ratio) | | |
|---|---|---|---|
| | **Monsanto** | **Bayer** | **BASF** |
| **Market index**[1] | 0.9670 (13.83)*** | 0.7164 (13.34)*** | 1.0967 (9.13)*** |
| **-10**[2] | -0.0021 (-0.07) | -0.0203 (-0.94) | 0.0086 (0.18) |
| **-9** | 0.0201 (0.64) | 0.0066 (0.31) | -0.0050 (-0.10) |
| **-8** | -0.0187 (-0.60) | 0.0037 (0.17) | 0.0108 (0.22) |
| **-7** | -0.0104 (-0.33) | 0.0154 (0.71) | -0.0211 (-0.44) |
| **-6** | 0.0002 (0.01) | 0.0042 (0.20) | -0.0049 (-0.10) |
| **-5** | -0.0003 (-0.01) | -0.0073 (-0.34) | -0.0052 (-0.11) |
| **-4** | -0.0260 (-0.83) | 0.0480 (2.23)** | 0.0279 (0.58) |
| **-3** | 0.0014 (0.04) | 0.0033 (0.15) | -0.0589 (-1.22) |
| **-2** | -0.0104 (-0.33) | 0.0054 (0.25) | 0.0106 (0.22) |
| **-1** | -0.0128 (-0.41) | -0.0010 (-0.05) | -0.0123 (-0.26) |
| **Day 0 (court rejects lawsuit)** | 0.0259 (0.82) | 0.0056 (0.26) | -0.0042 (-0.09) |
| **1** | 0.0221 (0.70) | -0.0096 (-0.45) | -0.0068 (-0.14) |
| **2** | 0.0190 (0.60) | 0.0092 (0.43) | -0.0018 (-0.04) |
| **3** | -0.0153 (-0.49) | -0.0112 (-0.52) | -0.0025 (-0.05) |
| **4** | -0.0474 (-1.50) | -0.0041 (-0.19) | -0.0129 (-0.27) |
| **5** | -0.0349 (-1.11) | 0.0134 (0.62) | 0.0127 (0.26) |
| **6** | 0.0199 (0.63) | -0.0046 (-0.22) | 0.0259 (0.54) |
| **7** | -0.0098 (-0.31) | 0.0078 (0.36) | -0.0212 (-0.44) |
| **8** | 0.0264 (0.84) | 0.0033 (0.15) | -0.0060 (-0.13) |
| **9** | 0.0056 (0.18) | -0.0102 (-0.47) | 0.0084 (0.17) |
| **10** | -0.0291 (-0.93) | -0.0505 (-2.34)** | -0.0387 (-0.80) |
| **Constant** | -0.0004 (-0.21) | 0.0001 (0.07) | 0.0029 (0.98) |
| **CAR** | -0.0767 | 0.0072 | -0.0967 |
| **[90% CI of CAR]**[3] | [-0.2327, 0.0648] | [-0.1401, 0.1250] | [-0.2420, 0.0403] |
| **Adj $R^2$** | 0.38 | 0.38 | 0.20 |

1) S&P 500 is used as market index for Monsanto, the DAX is used for Bayer and BASF. 2) '-10' denotes 10 days before the event date. 3) 90% confidence intervals (90% CI) of CARs are constructed using non-parametric bootstrap. *, **, and *** denote significance at the 10, 5 and 1% level, respectively.