# AGRICULTURE AND CITIZEN COMPLAINTS

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## 1. INTRODUCTION

Increasing levels of regulation have been imposed on the agricultural sector in response to concerns that farming can have detrimental impacts on environmental quality. Many of the policy instruments have been targeted to livestock operators, who have grown significantly in size and intensity over the years. The severity of the regulations varies geographically as documented by Metcalf and Beghin (2000) but a typical regional by-law involves the submission of a nutrient management plan (NMP) before a building permit is issued for the construction of a new barn. Random inspections after the facility is built are used to ensure the NMP is being followed.

Several unanswered questions face policy makers designing cost-effective environmental regulations for the farm sector. For example, it is assumed that increasing regulations will reduce the number of spills and environmental degradation. However, it is not clear whether restrictions on management practices, aside from complete prohibition of production, can limit dissatisfaction with farmers from local residents. Similarly, little is known about the relationship between complaints and spills. Since third party random inspections are an increasingly common form of ensuring compliance, reports of violations by local citizens can serve as a cost-effective means of targeting potential polluters. On the other hand, the complaints may be coming disproportionately from regions with higher than average education and income levels. Residents of such areas are more likely to have the desire to improve environmental health and have both the expertise and means to lodge effective local action through complaints. Another potential problem using complaints within the regulation process is that the complaints may not be directly related to violations. Within the livestock sector, complaints are often related to nuisance issues such as odour rather than directly correlated to environmental problems such as excessive nutrient levels in groundwater. Thus, complaints may not be an accurate measurement of regulation non-compliance and thereby an ineffective information tool for enforcement.

Previous research into the relationship between spills, regulations, and citizen complaints is limited. Russell, Harrington and Vaughan (1986) note the regional variability in complaints to the US EPA and suggest that the variation is due to factors other than environmental quality but no analysis was conducted to test the hypothesis. These authors found few of the complaints, which were all investigated, resulted in convictions for polluters suggesting that complaints may not be a cost effective means of monitoring. The relationship between citizen complaints and pollution levels was examined for China by Dasgupta and Wheeler (1996) and for Indonesia by Pargal and Wheeler (1996). Higher education levels increased the probability of filing complaints bringing into question the accuracy of citizen complaints. Authors () found within a developed country context that increases in wealth and income were positively related to complaint rates and that these rates were weakly related to actual pollution spills, except in the case of discharges to the air. None of these studies have examined whether complaints against agricultural producers are an accurate signal of pollution or a measure of local preferences. Nor have they examined the influence of environmental regulations on the level of spills and the rate of citizen complaints.

The purpose of this paper is to examine the characteristics of citizen complaints about local agricultural practices. The paper addresses the regional characteristics where spills occur, if these spills are generating complaints, and what types of citizens are doing the complaining. It also determines whether local regulations affect emissions and complaints. The paper begins by developing a theoretical model of the decision to lodge a complaint by a representative citizen. The next section describes the unique data set available to test the hypotheses. The set includes the number and type of complaints lodged against agricultural producers, socio-economic characteristics of the local citizens, characteristics of the regional agricultural sector including the severity of local environmental regulations, and the number and type of self-reported pollution discharges by farmers for 167 municipalities in the province of Ontario over a 4 year period. The fourth section describes the major results and the final section concludes with implications of the findings.

## 2. THEORETICAL MODEL

To address the several questions surrounding the relationships between environmental regulations, pollution discharges and complaints, we begin by modeling the effects of regulations ($R_j$) on the number of agricultural spills of type *a* in region *j* ($S_{aj}$). We will assume that

$$S_{aj} = S\ (R_j,\ L_{jk}) \qquad (1)$$

where $L_{jk}$ is the number of livestock farms in region *j* of type *k*. We hypothesize that increasing the stringency of regulations decreases the likelihood of spills ($\partial S/\partial R < 0$) while increasing the density of livestock farms has the opposite effect ($\partial S/\partial L > 0$). The latter marginal effect will vary between spill and farm types. For example, spills into waterways are more likely to occur from swine farms with large volumes of liquid manure than from poultry farms with relatively smaller amounts of dry manure.

Spills have a negative effect on environmental quality within a given region (*Q*). Regulations affect *Q* indirectly by reducing the number of agricultural spills (equation 1) but also act as a proxy for efforts such as stream rehabilitation that serve to improve environmental health in general. The level of *Q* also depends on physical characteristics of the region (*Z*). For example, *Q* will be higher in wilderness areas than densely populated urban areas. Finally, it is assumed that environmental quality improves with the per capita rate of complaining regarding affected resource *m* in region *j* ($C_{jm}$). Total number of complaints in a region is the average number of complaints registered by an individual (*c*) multiplied by total population for the region (*POP*). Thus,

$$Q_j = Q_j\ (S_{aj},\ R_j,\ C_{jm},\ Z) \qquad (2)$$

Whether an individual in a given region lodges a complaint of type *m* ($c_{jm}$) depends on whether the expected benefits of doing so in terms of improved environmental health outweigh the costs of lodging the complaint. This decision to complain is assumed to be the result of a utility maximization problem in which the individual in region j derives satisfaction (U) from the level of purchased goods consumed (X), and the level of environmental quality for the region ($Q_j$) according to

$$U_{ij} = U_i (X_i, Q_j ; H_i, Z_j) \qquad (3)$$

where $H_i$ is a set of socio-economic characteristics of the individual and $Z_j$ is a set of regional characteristics.

Environmental quality is influenced by the set of variables summarized in equation (2). The other constraint to the utility maximization problem is with the allocation of effort and consequently purchasing power given by

$$P_x X_i + P_c(H_i) \cdot c_{ijm} = P_w(H_i)\, W_i + rA \qquad (4)$$

Where $P_x$ is the price of purchased goods *X*, $P_c$ is the cost of lodging an individual complaint *c*, $P_w$ is the wage rate per unit of time, *W* is the number of hours worked, and *r* is the rate of return on an asset base of *A*. Socio-economic characteristics (*H*) such as education and age influence both the wage rate and the cost of filing a complaint. Total income derived from employment ($P_w W$) and investments ($rA$) less the amount spent on complaining ($P_c c$) can be spent on consumption goods.

Upon substitution of equations (1), (2) and (4) into (3), results in the following utility function which is maximized through the number and type of complaints regarding environmental impacts of farm practices

$$\max_{c_{jm}} U\, [P_w'(H)W + rA' - P_c'(H)c_{jm},\, Q_j(S_{aj}(R_j, L_{jk}), R_j, c_{jm}POP_j , Z_j ; H_i, Z_j)] \qquad (5)$$

where the prime notation denotes monetary variables deflated by the price of consumption goods (e.g. $P_w' = P_w/P_x$).

The optimal number of individual complaints is found through solution to the following Kuhn-Tucker condition,

$$c_{jm} [ -U_x P_c' + U_Q \cdot Q_c \cdot POP] = 0$$

where $U_x$ and $U_Q$ are the marginal utilities for consumption and environmental quality respectively. At the optimum, the marginal costs of complaining in terms of the value of the reduction in the marginal utility of consumption is equal to the marginal benefits in terms of the incremental improvement in satisfaction derived from a better natural environment. The individual will not register a complaint if the marginal cost ($U_x P_c'$) is greater than the marginal benefit ($U_Q \cdot Q_c \cdot POP$) of doing so.

The decision to complain and the effect of exogenous variables such as environmental stringency are illustrated in Figure 1. Line AB represents a budget constraint with point A indicating that the representative citizen by spending all available income ($P_w'W + rA'$) on consumer goods could purchase $X^A$ and still enjoy $Q^A$ units of environmental quality. At point B, filing $c^B$ complaints improves environmental conditions to $Q^B$ but the process reduces disposable income ($P_w'W + rA' - P_c'c^B$) so that purchased goods are reduced to $X^B$. The trade-off between $X$ and $Q$ is illustrated through indifference curves such as $U^E$ where provides $U_1^E$ more satisfaction to the individual than the choice set given by $U_0^E$. For a consumer with a budget constraint of AB and preferences represented by the indifference curves $U^E$, consumption is maximized at E ($Q^E, X^E$) with $c^E$ complaints. If the consumer placed less value on the environment, the indifference curves would become flatter and would become horizontal if the consumer only derived satisfaction from the consumption of purchased goods. A relatively flat indifference curve such as $U^A$ would result in $X^A$ units of goods consumed and no complaints registered against potential polluters.

A consumer who is in a cleaner environment but with the same income level faces the budget constraint A'B'. Filing no complaints allows all income to be spent on buying $X^A$

consumer goods but environmental quality in the region is $Q^B$ rather than $Q^A$. The consumer with preferences represented by $U^E$ reported $c^E$ complaints in the poor quality environment but will not file any complaints yet enjoy a higher level of satisfaction in the cleaner region ($U_2^E > U_1^E$).

If the consumer faces a higher per unit price to lodge a complaint ($P'_c$) or the marginal effectiveness of a complaint on improving environmental quality decreases relative to the original scenario, the resource constraint shifts from AB to AD. With the same set of preferences as the original scenario ($U^E$), the optimal consumption levels are given by point F. In contrast to equilibrium E, consumption falls to $X^B$ and environmental quality falls to $Q^F$. The effect on the optimal number of complaints ($c^E$ vs $c^F$) depends on comparing $[(P_w'W+rA'-X^E)/P'^E_c]$ to $[(P_w'W+rA'-X^F)/P'^F_c]$ where $P_c^F > P_c^E$.

Higher income levels cause the resource constraint to shift upward. For example, an individual facing an environmental condition of $Q^A$ would be able to purchase $X^{A''}$ consumer goods rather than $X^A$ with a corresponding increase in income. Higher purchasing power results in a move in the budget constraint to A''B" and results in an optimal solution of $Q^B$, $X^{B''}$ for an individual with preferences represented by $U^E$. Thus, the higher income level results in a greater number of complaints.

## 3. DATA

Data on spills, regulations, complaints and regional characteristics were gathered at the municipal level for 12 counties in southwestern Ontario over the period 1993 to 1996. The counties selected are the location for most of the livestock farms in the province and, correspondingly, most of the complaints surrounding farming practices.

Spill data by agricultural producers was obtained from the Ontario Ministry of the Environment (MOE). The discharges represent violations that have been self-reported by the polluter. The spills are categorized by the medium of the discharge (land, water, air, or combination thereof) and by the effects (water contamination, soil contamination, or harmful to human and/or animal health). There were 126 reported spills by farmers over the four year period with a high of 38 in 1993 and a low of 22 spills in 1995. The majority of the 126 spills were onto land directly (49%) with 24% into water sources, 21% into a multi-medium, and 6% into air. Ninety of the 167 townships reported no spills from agriculture and 47 had only one reported spill.

The MOE was also the source for complaint data. There were 1014 phoned-in complaints against agriculture over the four-year period and this represent approximately 5% of the total complaints made to the MOE. The numbers of complaints were evenly distributed across the four years with a high of 286 made in 1996 and a low of 229 in 1995. All but 27 of the 167 townships reported a complaint against agriculture over the four years with most reporting multiple complaints. The complaints were categorized by type (odour, dust, pesticide, noise, litter etc.) and approximately half of the total in a given year were associated with odour.

Regulations are assumed to reduce the likelihood of spills and complaints. Regulations facing the livestock sector are proxied by several variables that are summarized in Table 1. Marchand and McEwan (1997) calculated a restricitiveness rating for each township based on the percentage of a 100 acre farm on which a hog farm could be built (Restrict). The number of manure storage days (Storage) required by new livestock facilities also represents a measure of regulation stringency. A larger storage allows the producer to apply waste less frequently and thereby reduce the likelihood of complaints. It will also reduce the probability of spills as the manure can be applied at times when the crop can take up the nutrients and thus reduce the chance of runoff. Most municipalities require that the barn have a minimum frontage and be located a minimum distance from neighbours and/or the roadway (MSD). The area required for building rather than production will increase with the required separation distances. Thus, the smaller the percentage of total land available for construction based on the minimum separation distance (MSD), the more restrictive the township MSD. The minimum distance from the waterway and minimum lot size for new barns (Lot Size) are also assumed to be negatively related to spills and complaints as the likelihood for contact with water resources and neighbours is reduced.

Regional characteristics are divided into three categories. The first measures the significance of the livestock sector within the municipality (L). The numbers of hogs (Hog) and dairy (Dairy) produced within each municipality and the growth rates in that production (Hog Growth and Dairy Growth) are assumed to be positively related to spills and complaints. Livestock intensity is assumed to increase the likelihood of spills and thus, complaints.

The second category of regional characteristics is physical (Z). The ruralness of a region is proxied by the percentage of the township zoned agriculture (Rural). Spills are likely to be greater but complaints less in areas with a larger share of land devoted to farming. Complaints are assumed to be greater in those areas located next to a Great Lake. Cottage owners along the shoreline are more likely to oppose farm practices that will negatively affect their outdoor experience.

The third regional category is socio-economic (H). While spills are assumed to be unaffected by such factors, these variables will influence the relative net benefits of complaints. Population density (Popn) and growth (Popn Growth) are assumed to have a direct correlation with the likelihood of complaints. More people imply a greater chance for conflict between farmers and their neighbours surrounding appropriate practices. The greater the percentage of the labour force employed by agriculture (Farm Work) and unemployed (UE) the lower the probability of complaints. Economic pressures resulting from complaints against farmers will negatively affect those employed within the agricultural sector and also reduce the likelihood of employment for those seeking jobs. Education is measured as the percentage of the population with a university degree. Higher levels of education decrease the cost of lodging a complaint and increase the incentive for doing so since the individual may be more aware of the environmental impacts. Thus, education increases the likelihood of complaints. Wealth is measured in terms of average value of dwellings (Assets) and average employment income (Income). While increases in wealth increase the opportunity cost of complaining, the marginal satisfaction of improving environmental quality through citizen action is greater. The later effect is assumed to dominate the former so that increases and wealth are assumed to increase the likelihood and number of complaints. The summary statistics for these explanatory variables are reported in Table 1.

## 4. RESULTS

### 4.1. Spills

The theoretical model hypothesized that spills in a municipality were inversely related to environmental regulations while livestock production would have the opposite effect. The comparison of the means for these variables between regions experiencing spills and those did not is consistent with the assumptions (see Table 1). The regions with no spills from agriculture required on average larger manure storages, further distances from waterway, and larger lot size. Similar results were obtained under the logit regression model but only the effect of the manure storage was statistically significant (see Table 2). Having more storage capacity provides greater opportunity to spread livestock waste at times of the year with greatest chance for nutrient uptake and therefore less chance of runoff.

Agricultural characteristics had little effect on the likelihood of a self-reported spill from farming. A comparison of the means in Table 1 suggests that more intensive livestock regions have fewer spills on average. The logit regression coefficients have the expected signs but the effects are not statistically significant. The only agricultural variable that is significant is the percentage of the region that is zoned for agriculture. Thus, spills are more likely to occur in rural areas, as expected, but not necessarily those that are livestock intensive.

### 4.2. Complaints

There is a positive, albeit weak, relationship between the occurrence of spills and the lodging of complaints within a municipality. The average number of spills in a region with no complaints is 4.5 while it is 7.8 in regions with complaints (see Table 1). The former is influenced by one municipality for which there were no self-reported spills but which had 85 complaints registered over time. The variation in the relationship between spills and complaints is illustrated in the scatter plot of Figure 2. An OLS regression of the data suggests that 2 complaints are generated for every spill on average but the R-squared is only 0.05. Differences in the severity of the spills may result in differing numbers of complaints and result in the noisy relationship suggested by Figure 2.

The factors affecting the likelihood of complaints were determined through a logit regression model and the results are listed in Table 2. As implied by Figure 2 and Table 1, the occurrence of a spill has a statistically significant positive effect on the probability of a complaint being filed in a region. The stringency of environmental regulations has a mixed effect on the likelihood of complaining depending on the by-law. However, the only statistically significant variable is the minimum distance separation requirement between the livestock facility and a waterway (MSD). As expected, an increase in MSD decreases the likelihood of an obvious detrimental effect of livestock production on water and thus the likelihood of complaining.

Regional characteristics appear to have little effect on the probability of complaints. Surprisingly, the growth rate in hog production has a negative effect. Most of the media coverage and citizen concern appears to be directed toward large-scale hog operations. While these concerns may affect the location of farming operations, it does not appear to have an effect on the number of complaints. In fact, most of the growth in hogs has occurred within the traditional hog production municipalities of Huron and Perth counties, and relatively few complaints were registered in those regions. A factor that does significantly affect the likelihood of complaints is the percentage of the region that is zoned for agriculture. Given the statistically insignificant effects of population density and growth, the result suggests that complaints are more likely associated in regions with scattered development that invites more potential conflict between farmers and their non-farm neighbours. The final statistically significant variable is the average value of the dwelling within a region. Increases in wealth have a positive effect on the probability of complaining as expected since the relative costs of a decrease in property value of degradation in the local environment will be greater for higher value regions.

## 5. CONCLUSIONS

The paper has addressed the relationship between agricultural spills and environmental complaints filed by citizens against agriculture. It has also determined the influence of other factors on the likelihood of both farm spills and complaints within a region. The relationships have been estimated using a unique data set containing the number of spills and complaints along with regional data such as the stringency of environmental regulations and socio-economic variables.

Different environmental regulations do appear to have an effect on the spills and complaints. By-laws on the size of manure storage facility in relation to the number of livestock housed influence the likelihood of spills within a region. Larger storages decrease the number of annual manure applications and thus the opportunity for runoff. While the required distance between a new barn and a waterway appears to have no effect on the likelihood of spills, it does decrease the probability of complaints being lodged against agriculture. Increases in the percentage of the regions zoned as agriculture also decreases the likelihood of complaining. Together the results suggest that distance between livestock producers and both environmentally sensitive areas and people are an effective means to reduce conflicts between farmers and the local community.

Another policy question raised in the study was the effectiveness of using citizen complaints as an information tool in addressing environmental quality issues surrounding agriculture. There is a positive, albeit weak, positive influence between spills in a region and the number of complaints. Complaints could be used to indicate problem areas but the information signal will be noisy. Regulators will have to be aware that such complaints are more likely to come from wealthy areas when deciding upon how to react to complaints. The weak results on the factors affecting complaints suggest that other variables need to be included within the model such as the type of spills. In addition, future research will use a two stage procedure to first determine the likelihood of complaints and then the number of complaints given that one has been filed.

## 6. REFERENCES


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**Table 1. Means (and Standard Deviations) for Variables, by Region Categorized by Number of Agricultural Spills and Complaints**

| | | Regions with | | Regions with | |
|---|---|---|---|---|---|
| Variable | Definition | No Spills | ≥ 1 Spill | No Complaints | ≥ 1 Complaint |
| **Spills (S)** | | | | 4.5<br>(9.6) | 7.8<br>(10.8) |
| **Environmental Regulations (R)** | | | | | |
| Restrict | % of land available for barn based on minimum separation distances | 51.4<br>(26.2) | 54.5<br>(25.3) | 58.3<br>(27.1) | 51.7<br>(25.4) |
| Storage | Number of manure storage days required | 104.9<br>(101.2) | 89.1<br>(105.9) | 81.5<br>(93.0) | 100.8<br>(105.3) |
| MSD | Minimum distance barn must be from waterway (m) | 22.8<br>(25.9) | 18.9<br>(21.2) | 23.4<br>(28.7) | 20.5<br>(22.9) |
| Lot Size | Minimum lot size for barn | 58.7<br>(25.8) | 52.7<br>(27.9) | 61.1<br>(25.2) | 55.0<br>(27.1) |
| **Agricultural Characteristics (L)** | | | | | |
| Hog | Number of hogs per ha | 1590.8<br>(1043.8) | 1301.0<br>(917.5) | 1389.0<br>(935.3) | 1469.3<br>(1007.3) |
| Hog Growth | % change in production between 1991 to 1996 | 79.1<br>(449.5) | 4.4<br>(223.5) | 16.6<br>(161.3) | 49.5<br>(387.2) |
| Dairy | Number of dairy cows per ha | 1361.0<br>(1465.8) | 1260.2<br>(1622.9) | 1175.3<br>(828.3) | 1335.6<br>(1613.4) |
| Dairy Growth | % change in production between 1991 to 1996 | 84.2<br>(303.1) | 17.1<br>(121.4) | 27.7<br>(198.6) | 55.4<br>(241.1) |
| **Physical Characteristics (Z)** | | | | | |
| Rural | % of area zoned agricultural | 76.2<br>(19.9) | 82.5<br>(13.3) | 72.5<br>(24.1) | 80.3<br>(15.6) |
| Recreation | =1 if located next to a Great Lake | 0.37<br>(0.48) | 0.31<br>(0.47) | 0.<br>(0.47) | 0.32<br>(. |
| **Socio-Economic Characteristics (H)** | | | | | |
| Popn | Population density ('000/km$^2$) | 47.1<br>(120.2) | 90.3<br>(258.9) | 105.0<br>(259.7) | 59.7<br>(183.0) |
| Popn Growth | % change in production between 1991 to 1996 | 4.4<br>(5.8) | 4.2<br>(5.4) | 4.9<br>(4.5) | 4.2<br>(5.8) |
| Farm Work | % of labour force in agriculture | 15.7<br>(11.1) | 18.4<br>(10.2) | 14.0<br>(11.4) | 17.5<br>(10.5) |
| UE | Unemployment rate (%) | 6.3<br>(2.5) | 6.0<br>(2.6) | 7.3<br>(3.1) | 5.9<br>(2.4) |
| Education | % of population with at least a university degree | 11.7<br>(4.5) | 11.7<br>(4.8) | 10.6<br>(4.9) | 11.9<br>(4.6) |
| Wealth | | | | | |
| Assets | Average value of dwelling ($ '000) | 154.6<br>(35.6) | 159.5<br>(36.4) | 149.1<br>(35.4) | 158.4<br>(35.9) |
| Income | Average employment income ($'000) | 24.4<br>(4.7) | 25.1<br>(4.8) | 23.7<br>(5.3) | 24.9<br>(4.7) |
| Number | 177 townships | 90 | 67 | 27 | 140 |

## Table 2. Logit Regression Results for Factors Explaining the Likelihood of Agricultural Spills and Complaints against Agriculture within a Municipality

| Explanatory Variable | Spills | Complaints |
|---|---|---|
| **Intercept** | -1.919 | -1.694 |
| | (-1.218) | (-0.322) |
| **Spills (S)** | | |
| | | **0.989** |
| | | **(1.663)** |
| **Environmental Regulations (R)** | | |
| Restrict | 0.004 | -0.013 |
| | (0.486) | (-0.838) |
| Storage | **-0.003** | 0.011 |
| | **(-1.533)** | (1.266) |
| MSD | -0.005 | **-0.019** |
| | (-0.499) | **(-1.712)** |
| Lot Size | 0.003 | 0.003 |
| | (0.321) | (0.017) |
| **Agricultural Characteristics (L)** | | |
| Hog | 0.00006 | -0.00007 |
| | (0.024) | (-0.136) |
| Hog Growth | 0.002 | **-0.003** |
| | (0.958) | **(-1.770)** |
| Dairy | 0.0002 | 0.0001 |
| | (1.253) | (0.347) |
| Dairy Growth | -0.003 | 0.002 |
| | (-1.397) | (0.837) |
| **Physical Characteristics (Z)** | | |
| Rural | **0.021** | **-0.009** |
| | **(1.413)** | **(-1.413)** |
| Recreation | | -0.221 |
| | | (-0.233) |
| **Socio-Economic Characteristics (H)** | | |
| Popn | | -0.003 |
| | | (-1.187) |
| Popn Growth | | -0.021 |
| | | (-0.308) |
| Farm Work | | 0.033 |
| | | (0.553) |
| UE | | 0.024 |
| | | (0.135) |
| Education | | 0.007 |
| | | (0.045) |
| Wealth | | **0.0002** |
| Assets | | **(1.663)** |
| Income | | -0.00001 |
| | | (-0.649) |
| | | |
| Pseudo R-squared | 0.067 | 0.204 |
| Log-Likelihood | -67.08 | -32.57 |

*z-values in parenthesis

Coefficients significant at the 90% confidence level are in bold.

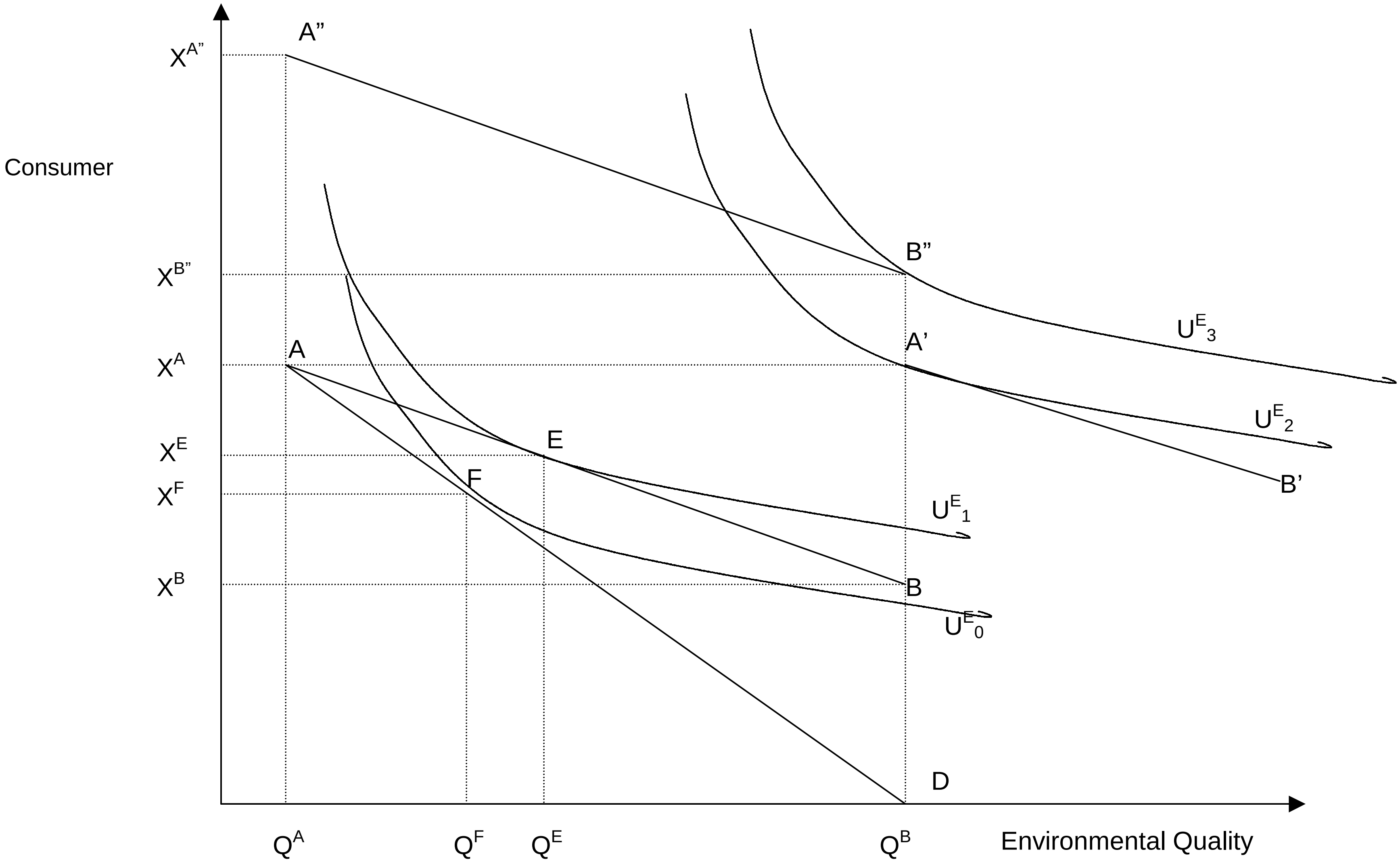


**Figure 1. Environmental Quality – Consumption Tradeoff and the Likelihood of Complaining**

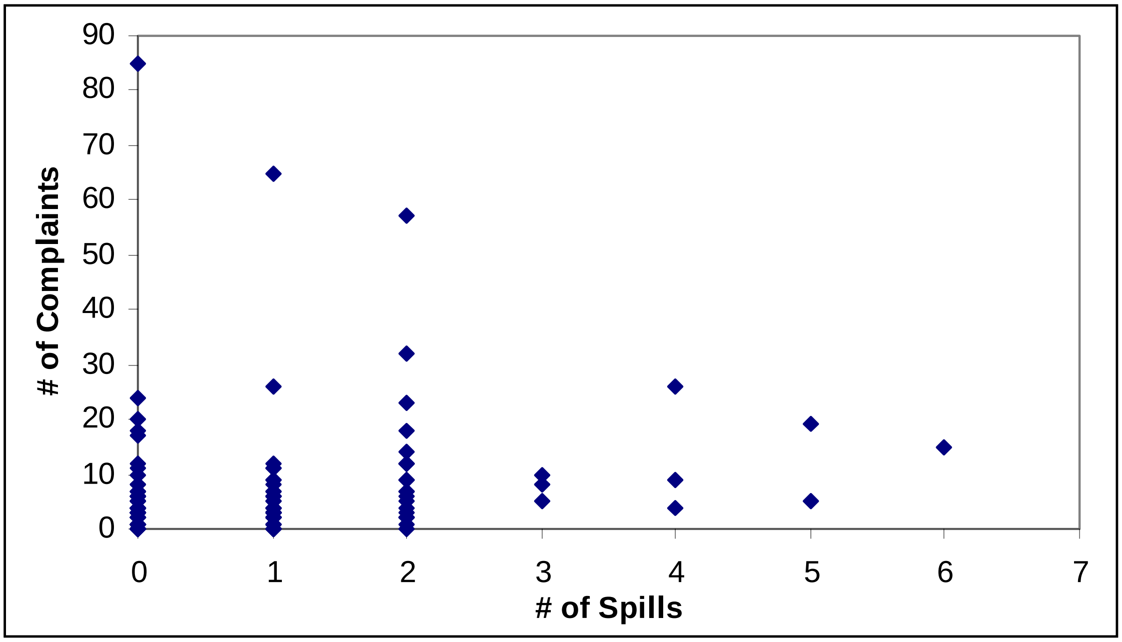


**Figure 2. Relationship between Number of Agricultural Spills and Complaints by Municipality**