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Cartel Destabilization and Leniency Programs – Empirical Evidence

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Non Technical Summary

Free competition on markets is a major concern in competition policy. The cartelization of firms is a threat to free competition. One major instrument antitrust authorities have and use increasingly frequently is leniency programs. Leniency programs, as a device for cartel detection and cartel destabilization, have been implemented, or reformed, across countries since the early nineties (i.e. USA 1993, European Union 1996). These programs allow for cartel fine avoidance or at least for significant reductions of fines for a cartel member who denounces a cartel. Theoretical literature widely analyzed leniency programs, showing that they can be an effective tool to destabilize, detect and deter cartels. However, it is possible for the opposite effect to occur. For instance, an increase in the number of cartels may occur, due to lower expected costs of fines, which in turn stimulates cartelization. Empirical literature tries to analyze whether leniency programs are effective but stays inconclusive given that identification is derived solely from detected cartels. Therefore, it is not clear whether a possible success of a leniency program, which is indicated by an increasing number of uncovered cartels, is due to more efficient cartel prosecution or due to a greater pool of existent cartels.

This paper attempts to answer these open questions. The efficiency of leniency programs is measured empirically by the impact on the competition intensity. As a widely used measure I employ the price cost margin. Econometric estimations based on OECD data for 23 countries and a period of 20 years shows positive and significant effects of leniency programs on the competition intensity. This result indicates that leniency programs are an effective device for cartel detection and cartel destabilization.

Das Wichtigste in Kürze

Freier Wettbewerb auf Märkten ist eines der wichtigen Ziele der Wettbewerbspolitik. Eine Gefahr für diesen freien Wettbewerb sind Kartelle. Wettbewerbsbehörden setzen zunehmend auf die Kronzeugenregelung, um Kartelle zu entdecken und zu destabilisieren. Solche Programme wurden in den frühen neunziger Jahren eingeführt oder reformiert (USA 1993, Europäische Union 1996). Diese Programme geben Kartellmitgliedern die Möglichkeit eine Kartellstrafe zu umgehen oder zumindest signifikant zu verringern, indem sie ein Kartell anzeigen. Die Wirksamkeit der Kronzeugenregelung als effektives Werkzeug zur Kartellerkennung und Destabilisierung wurde in der theoretischen Literatur weitgehend bestätigt. Es sind jedoch auch gegenteilige Effekte möglich. Zum Beispiel ist es möglich, dass die Einführung der Kronzeugenregelung die erwarteten Kartellstrafen insgesamt senkt und somit die Bildung von Kartellen stimuliert. Die empirische Literatur ist bislang unschlüssig über die Effektivität der Kronzeugenreglung. Es ist nicht klar, ob ein möglicher Erfolg der Kronzeugenregelung, gemessen durch mehr entdeckte Kartelle, eine effizientere Verfolgung oder nur eine größere Basis an existierenden Kartellen darstellt.

Dieses Papier versucht diese noch offene Frage zu beantworten. Hierbei wird die Effizienz der Kronzeugenreglung empirisch anhand des direkten Einflusses auf die Wettbewerbsintensität gemessen. Als weit verbreitetes Maß der Wettbewerbsintensität dient die Preiskostenmarge. Ökonometrische Schätzungen auf Basis von OECD Daten für 23 Länder und einen Zeitraum von 20 Jahren, zeigen, positive und signifikante Effekte der Kronzeugenregelung für die Wettbewerbsintensität. Daraus folgt, dass die Kronzeugenreglung ein effektives Mittel zum Aufdecken und Destabilisieren von Kartellen ist.

Cartel Destabilization and Leniency Programs - Empirical Evidence

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Abstract

Leniency programs as a tool for cartel detection and cartel destabilization, have been implemented since the early nineties. Theoretical work has shown that leniency programs can be effective in enhancing cartel detection and deterrence, but these effects are not straightforward. It is even possible that there is an increase in the total number of cartels. Empirical evidence shows that the positive effect on cartel deterrence seems to dominate, but cannot provide definite evidence, as inference is derived only by detected cartels. This study uses a more direct measure of success, the intensity of competition at the industry level of OECD countries. An instrumental variable approach, reveals a positive effect on industries' competition intensity of leniency programs indicating effectiveness in cartel destabilization and effective deterrence.

Keywords: Cartel, Antitrust, Leniency Program

JEL Classification: C23, K21, K42, L41.

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1 Introduction

Free competition on markets is a major concern in competition policy. A threat to free competition is the cartelization of firms. One major instrument antitrust authorities have and use increasingly frequently are leniency programs. Leniency programs, as a device for cartel detection and cartel destabilization, have been implemented, or reformed, across countries since the early nineties (i.e. USA 1993, European Union 1996). These programs allow for cartel fine avoidance or at least for significant reductions of fines for a cartel member who reports a cartel and should provide incentives to whistle-blowing. Theoretical literature widely analyzed leniency programs, showing that they can be an effective tool to destabilize, detect and deter cartels (Hinloopen 2003, Motta and Polo 2003, Spagnolo 2004, Chen and Harrington 2007). However, negative effects are possible as well. For instance, an increase in the number of cartels may occur, due to lower expected values of fines, which is a threat to the efficiency of leniency programs (Motta and Polo 2003, Chen and Harrington 2007, Harrington 2008). Empirical literature tries to analyze whether leniency programs are effective but stays inconclusive as identification is only derived from detected cartels (Brenner 2009, Miller 2009). Therefore, it is not clear whether a possible success of a leniency program that is indicated by more uncovered cartels is due to more efficient cartel prosecution or due to more existent cartels.[1]

This paper attempts to go a step further in the identification of effectiveness of leniency programs. First, I argue that the efficiency of leniency programs can be derived empirically by analyzing its direct impact on competition intensity. Competition intensity is an appropriate measure of success of the effectiveness of leniency programs, because the ultimate goal of leniency programs is to deter collusion and cartels that are supposed to lower competition intensity. Secondly, I apply a widely used measure for competition intensity and show empirically that leniency programs in place lead to increased competition intensity and are therefore an effective tool for destroying or avoiding cartels. In executing these two steps, this paper adds empirical evidence to the literature regarding the effectiveness of leniency programs.

The analysis relies on the theoretical literature and identifies the main objective of leniency programs, to increase, or at least to sustain, the level of competition. To check the hypothesis of leniency programs' effectiveness, the empirical analysis uses the OECD Structural Analysis Database (STAN), which provides information on industry level characteristics. This data allows to build a measure of the average profitability of industries, which is an increasing function of the price cost margin (PCM) that is used as a measure of competition intensity at the industry level. The analysis therefore relates to the literature that analyzes effectiveness of competition

[1] This issue is discussed in detail in section 2.

enhancing policies by using the same measure as, however, an endogenous variable (Griffith et al. 2007, Griffith et al. 2010) or as a control variable (Buccirossi et al. 2009, Aghion et al. 2009). In conjunction with supplementary data of antitrust agencies and various other OECD statistics, an unbalanced panel comprising 23 countries over a period of 20 years is built. Besides the information that is necessary to construct the PCM equivalent measure, it includes a great deal of other relevant information, which allows to control for competition intensity. Supplementary information is added from other OECD databases. In addition, data to control for policies that may have an effect on the competition intensity is used as well.

Identification follows an approach similarly proposed by Buccirossi et al. (2009) in order to take account of the two main sources of bias: endogeneity and omitted variable bias. First, I control for several side factors, which have an impact on competition intensity such as imports, business cycles, product market regulation as well as competition affecting policies. Secondly, an instrumental variable approach using different sets of instruments to test for endogeneity and omitted variable bias is applied. In particular, I use the implementation of leniency programs on the OECD level as well as indicators for the political environment provided by the Manifesto database (Klingemann et al. 2006). These different instruments allow to build an appropriate predictor for the application of leniency programs and offer the opportunity for consistency tests. Thirdly, to check for robustness, I provide several tests controlling for the impact of the European supranational leniency programs, temporal persistence of leniency programs and for the specific legal system in which leniency programs are used.

The results indicate a positive impact of leniency programs on competition intensity, with an approximate decrease of the PCM of 3% to 5%. Moreover, the instrumental variable estimation reveals that these results do not suffer from significant endogeneity or omitted variable bias. Thus, national leniency programs can be denoted to work efficiently in detecting and deterring cartels. This result is in line with previous findings, deriving identification from discovered cartels only. Robustness checks show that the impact of leniency programs takes on average a period of one year to become effective. In addition, I can show that leniency programs are dependent on the legal environment where they are implemented. As a side finding, estimations cannot verify a robust impact of the European supranational leniency programs. Finally, the overall analysis shows that efficiency of antitrust programs in general may potentially be appropriately estimated using competition intensity as a success measure.

The outline of the paper is the following: Section 2 provides a background discussion and derives the hypothesis. Section 3 presents the empirical strategy, section 4 discusses the data and provides descriptive statistics. Section 5 provides empirical results, and section 6 concludes.

2 Literature Review and Background Discussion

Leniency programs in antitrust have formally been existent since 1978, when they were implemented in the US. However, they were hardly used before a major revision by the US Antitrust Division of the Department of Justice in 1993 that allowed for fine avoidance in case of a cartel reporting (OECD 2002). The revision's large success in the detection of cartels led several other countries to install similar programs (i.e. EU, UK, Korea, New Zealand). In particular, the EU implemented a program in 1996 which was substantially revised in 2002.

Analyzing the effectiveness of those programs requires to define the objectives first. The primary objective of leniency programs, as of antitrust laws in general, is to deter cartels or harmful behavior (Spagnolo 2008). This primary objective can be separated into two parts: Ex ante or general deterrence and ex post deterrence or desistance. In other words, these two derived objectives imply prevention of cartels either before they occur or prosecution due to the detection of already existing cartels.[2]

Theoretical literature provides evidence that leniency programs can be an effective tool to deter cartels and therefore can be effective in achieving the primary objective. For instance, Spagnolo (2004) identifies in a static model conditions for an efficient setup of leniency programs. In particular, a program which grants exclusive reductions of fines to the first confessor only, is identified to have the strongest deterrence effect. He finds those effects as well, albeit smaller, in less strict programs, where second or third parties reporting a cartel receive some reductions in sanctions as well. The analysis from Aubert et al. (2006) focuses on the incentives of rewards and fines. These rewards are granted additionally on top of the leniency. Aubert et al. (2006) show that reduced fines can have a positive impact on deterrence, but that programs offering rewards, especially if individuals are included, may have an even larger impact. Motta and Polo (2003) introduce a welfare maximizing antitrust authority, endogenizing the process of detection. In particular, they consider the effects of leniency programs of firms on their incentives either on collusion (ex-ante) or revealing information after collusion took place (ex-post). They show that leniency programs may well enhance the ex-post detection and therefore desistence but may have pro-collusive effects as expected fines may decrease. Therefore, a negative effect on deterrence may be possible such that a leniency program leads to an increase in cartels. In a different setting, Chen and Harrington (2007) provide an analysis using a dynamic model. They conclude that a strong leniency program has significant deterrence effects, but softer leniency programs may have adverse effects on deterrence. This is in line with Motta and Polo (2003).

[2]Spagnolo (2008) notices that the first objective, however, is by far more important as prosecution without any deterrence leads only to deadweight due to the social costs of the prosection. However, it is expected that there is always some deterrence effect.

In addition, they identify a lower price in the overall pricing of cartels due to leniency programs even if no deterrence effects are identified.

These ambiguous pro-collusive effects and anti-collusive deterrence effects are explained and considered in a theoretical analysis by Harrington (2008) by three main channels. First, the *Deviator Amnesty Effect* changes the pay-off of a firm when cheating in a cartel and lowers the expected utility a firm has of collusion, indicating positive effects on deterrence. Secondly, the *Cartel Amnesty Effect*, however, lowers the expected size of the sanctions such that the expected utility a firm has due to collusion may increase, implying less cartels than in an environment without leniency. The third effect is the *Race to the Courthouse Effect*. This effect may lower expected values from colluding if less stricter programs, which offers some leniency to more than the first confessor, are in place. This effect implies less collusion. In particular, the *Race to the Courthouse Effect* is claimed to be a countervailing force for the *Cartel Amnesty Effect*. Finally, concluding that theoretical literature provides strong evidence that leniency programs may reduce cartel stability, Harrington (2008) mentions that strong empirical evidence is missing, in particular due to data restrictions only on detected cartels.

There are empirical studies considering whether there has been an increase in cartel detection and deterrence due to leniency programs. Brenner (2009) uses a sample of 61 cartel cases investigated and prosecuted by the European Commission between 1990 and 2003. Evaluation of efficiency distinguishes between short (information revelation, investigation and prosecution costs reduction) and long run effects (deterrence of collusion). While there seems to be an effect on short run effects, he cannot find a significant effect on long run effects. Miller (2009) finds different evidence for cartel detection in the US. Directly after introducing leniency programs, there was an increase of cartel detection in the US, which decreased later onto a level that was below the pre-leniency detection level. This decrease is interpreted with higher cartel deterrence. His analysis relies on hypotheses derived from a theoretical dynamic model and an empirical analysis using cartel detection to derive inference. Moreover, his predictions rely on a single time series and on the representability of detected cartels. The study by Miller is a large step in providing substantial evidence that leniency programs lead to more deterrence and less collusion. However, a final conclusion is still missing, since the identification is only derived by data from detected cartels.

Measures like detected cartels are easily available, but this measure should be analyzed with caution. It may capture success, such as cartel detection, but this could be the result of more existent cartels. Moreover, a reduction in cartel detection, which may reflect less overall cartel activity could be interpreted as a failure of leniency programs. Clearly, data on undetected cartels is not available. This is due to the fact that cartels are per se illegal and not observable

(Spagnolo 2008). I propose to solve this measurement problem by implementing a different, more direct measure of success. In particular, an effective leniency program leads to a situation with less cartels after the implementation of such a program. If we expect that cartels lead to a less competitive outcome (for example collusive outcome vs. oligopoly outcome), the counterfactual hypothesis for a test of effectiveness of leniency programs should be whether there is a more competitive environment after the implementation of a leniency program. Therefore, effectiveness of cartels can be analyzed by investigating the intensity of competition in possibly cartelized industries. If, ceteris paribus, competition intensity increases due to the implementation of leniency programs, a leniency program is effective.

3 Empirical Strategy

3.1 Empirical Modeling

The objective of this study is to analyze whether leniency programs can deter and destroy cartels to improve the competitive situation in industries across OECD countries. The central relationship I want to estimate is captured in the following form:

$$ln(Y_{i,t}) = \beta_L Leniency_{i,t-2} + \beta_P Policies_{i,t-2} + \beta_X ln(X_{i,t-1}) + \epsilon_{i,t} \quad (1)$$

with Y as a measure of the industries' competition intensity,[3] *Leniency* as an indicator whether a Leniency program is in place, *Policies* as a vector of other competition affecting policies, X as a vector of other control variables[4] and ϵ as the error term. The error term is defined as $\epsilon_{i,t} = \omega_{i,t} + \phi_{i,t} + u_{i,t}$, with $\omega_{i,t}$ capturing time dummies, $\phi_{i,t}$ country-industry specific fixed effects and $u_{i,t}$ the remaining error. In particular, I estimate the impact of leniency programs on the competition intensity to measure the success more directly than previous studies did. They measured the success of leniency programs indirectly using data on detected cartels only. A positive competition enhancing effect of leniency programs is denoted to be an indicator for more destroyed cartels (either detected or deterred).

[3] All variables are defined in detail in section four.

[4] All continuous variables, PCM and controls in X are used as logs to give more weight to smaller values and to reduce the impact of potential outliers.

3.2 Identification

Identification of the efficiency of implemented leniency programs is analyzed by evaluating the impact leniency programs have on competition intensity. Successful leniency programs should ultimately deter competition-harming behavior that reduces overall welfare. As pointed out before, cartels, by definition, try to cooperate in order to reduce competition to increase prices and profits of cartel members. If, ceteris paribus, cartels are deterred, a non-cooperative market outcome that is subject to more competition will arise. Therefore, instead of identifying deterred cartels (ex-ante or ex-post), which is impossible for ex-ante deterred cartels and for non-detected destabilized cartels, the analysis relies on the effect on the final goal of leniency programs, the increase of competition intensity.[5]

I consider several potential biases to identify a causal link between leniency programs and competition intensity in the estimation. For the estimation strategy, I follow similar steps and use similar controls as Buccirossi et al. (2009).[6] I try to eliminate endogeneity bias either resulting from two-way causality or omitted variable bias. Two-way causality, however, is less of a concern, as single, possibly collusive, industries are probably not responsible for an implementation of a leniency program. Implementation of such policy programs take a rather long time, as the design of laws is slow and requires effort. However, to reduce possible bias, lagged values of the leniency indicator variable are used.[7] Assuming that lagged values of the leniency variable are uncorrelated with the error term of the estimated equation (Buccirossi et al. 2009, Griffith and Harrison 2004) should consider two-way causality sufficiently.

Omitted variable bias is a significant concern as there are a lot of factors having an impact on the competition intensity of an industry. The time invariant factors are captured using industry-country specific fixed effects. Time invariant biases are partially tackled, introducing relevant controls. In particular, I control for foreign competition, business cycles, product market regulation and relevant policy programs.[8] Moreover, to reduce bias from omitted variables, I use an instrumental variable estimation to explicitly test for potential endogeneity. The instrument is the implementation of leniency programs in other OECD countries. While there is a correlation

[5] As previously discussed, Spagnolo (2008) mentions that it is the ultimate goal to deter (ex-ante or ex-post) competition reducing behavior to increase welfare.

[6] In contrast to my analysis, Buccirossi et al. (2009) analyze the impact of general antitrust policy on productivity. However, I use similar instruments and, where appropriate, a similar identification strategy for a similar industry level data set.

[7] I use, as for all policy variables, two year lags for the leniency program. This is due to the fact that it is not clear when within a year each policy was introduced. Therefore, a one year lag is used to ensure that all policies are in place. One more lag is introduced, as mentioned, to reduce bias of possible two-way causality. Continuous variables of the STAN data do only need a one year lag, as their measurement timing is parallel to the PCM.

[8] Many OECD countries within the sample are EU member states such that most of the policy program controls relate to EU programs.

between implementing leniency programs in the different OECD countries, there is no impact of the competition intensity in one country on the implementation of leniency program in another one. This correlation in the implementation is especially given due the cooperation on competition policies across OECD countries. To check robustness, I add other kinds of instruments, also proposed by Buccirossi et al. (2009). These instruments are indicators of the political position of the program of political parties which are elected into parliament. These indicators are provided by the Manifesto data (Klingemann et al. 2006). In particular, I control for countries' political parties' programs regarding tendency for the role of governments' economic planning (market regulation, controlling economy, economic planning) and the size and importance of a country's welfare state (social justice, welfare state expansion, welfare state limitation). Both sets of instruments should have explanatory power for the application of leniency programs, however, the latter ones are more certainly exogenous to competition intensity, while the first is potentially reversely affected by the intensity of competition.

In addition, I control for non-linearities of leniency programs, depending on the legal environment in which they are applied (see Buccirossi et al. 2009, La Porta et al. 2008). Leniency programs are interacted with different legal systems and it is checked whether there are dependencies. This part of the analysis uses a pooled OLS approach and country industry dummies instead of fixed effects, as the legal system is a time invariant factor that cannot be estimated using fixed effects.

4 Data & Descriptive Statistics

The data is composed of several data sources. The main source is the OECD Structural Analysis Database (STAN), which provides data on the industry level, of which I use information on the two digit NACE classification level. The data contains information on manufacturing industries as well as service industries.[9] In includes in particular various information about value added, exports, imports and capital formation. The data is complemented with information on leniency programs in place, provided by national antitrust authorities. Furthermore, information on interest rates, inflation and product market regulation from the OECD Reference Series, the OECD Key Economic Indicators database and the OECD Product Market Regulation database, is added. Information of relevant policy programs that is publicly available is added as well.

[9]Due to missing values in services industries, the analysis contains mostly information on manufacturing industries. An overview over the considered industries is provided in the appendix.

4.1 Competition Intensity

The dependent variable of interest to identify the efficiency of leniency programs is competition intensity. To measure this intensity of competition within an industry, I use a measure of average profitability. This is equivalent to the price cost margin (PCM) given the assumption of constant economies of scale and marginal costs equal to average costs.[10] Deviations lead, therefore, to under- or over-estimations. Although this drawback is existent, Griffith et al. (2010) claim that the PCM is certainly the best measure available for an international comparison of several countries in an international database. Lamentably, as Boone (2008a, 2008b) points out, the PCM is not robust to all industry constellations, especially if there is a reorganization of the industry due to tighter competition. He shows that tighter competition leads to shifts of production from less efficient to more efficient firms. These shifts in production may lead to a non-linear relationship between the PCM and competition intensity. However, in this particular analysis, the drawback is not an issue, because the interest lies in a change in the measure due to cartels deterrence or destruction. The reference point is a collusive outcome, indicating maximization of profits. If a firm deviates and destroys the cartel (or the cartel is detected by the antitrust authority), this will decrease overall industry profits, regardless of possible industry reorganization. Therefore, a reduction of the average profitability measure indicates destroyed cartels.[11]

The PCM equivalent measure, average profitability, is calculated by an industry's value added, divided by the sum of industry's capital costs and industry's labor costs:

$$PCM <=> Average\_Profitability_{i,t} = \frac{ValueAdded_{i,t}}{LaborCosts_{i,t} + CapitalCosts_{i,t}} \tag{2}$$

While there is information about value added and labor costs in the STAN data, capital costs are not included in the data.[12] To create an approximation for capital costs, the gross fixed capital is multiplied with a capital cost factor. This capital cost factor is equal to a risk-free interest rate plus the industries' average capital depreciation less the countries' inflation.[13] To capture the risk-free interest rate, I assume free capital flow and a unique world interest rate. For this, I use the US long term interest rate, available in the OECD Reference Series. The inflation is the country specific annual inflation rate, provided by the OECD Key Economic Indicators database. The capital depreciation rate is not provided directly, therefore, I use the STAN data

[10] Compare Klette (1999) & Griffith et al. (2010). In the following I use the terms *average profitability* and *PCM* synonymously.

[11] If the effect of the leniency programs on PCM is positive, this indicates that there will be more cartels.

[12] All values are computed using nominal prices.

[13] This measure has been similarly used by Griffith et al. (2010), Griffith et al. (2007) and Martins et al. (1996)

and calculate the average capital consumption over capital employed.[14] Capital deflators are added. For the observations for which they are not available, I use cross-country means of other countries in the same industry and year. The variable gross fixed capital is not available for all countries in the data, however, capital formation is more widely available. Therefore, I use the perpetual inventory method to calculate a measure of gross fixed capital.[15]

4.2 Main Explanatory Variable and Instruments

The main explanatory variable is the leniency program variable. Data is collected from information provided on the homepages of national antitrust authorities. As there have been several revisions of very heterogenous leniency programs, for EU countries, I use the information in which year a leniency program according to the European Competition Network's definition has been in place.[16] This ensures that heterogeneity of leniency programs observed is reduced and that it is ensured that the first confessor receives full amnesty. The variable is constructed as a dummy, indicating whether such a program exists at a given time. Moreover, two more dummy variables consider if an industry is affected by the European supranational leniency programs. Therefore, a dummy for the first EU leniency program in 1996 and its revision in 2002 are considered.[17] In addition, I add a variable indicating whether the countries' neighbors (if they are in the OECD) introduced leniency programs. This variable controls whether there are spillover effects. The reasoning behind is that there may be cartels across borders. This is even more the case in European countries, which have strong interrelated economies, but applies also to other countries. Therefore, there may be effects of cartels detected or deterred in neighbor countries.

To control for possible endogeneity, two kind of instruments for an instrumental variable estimation are constructed. First, the instrument provided is the percentage of other OECD countries having implemented a leniency program.[18] Due to international cooperation regarding antitrust policies, I suppose that the probability using a leniency program is increasing in the programs, implemented in other countries. Second, I use a set of political variables constructed from the

[14]This data is only available for a small subset of countries of rather different size. To have an appropriate rate not biased by small economies, I use the largest economy available for the data, which is Germany. Only for industries not available in German data, I use the average of all industries available.

[15]As the use of the perpetual inventory method always yields to volatile capital measures depending on the specific assumptions, all calculations are checked for whether the calculated capital measure influences results significantly. Results are consistent if gross fixed capital, as provided in the data, is used. The perpetual inventory method is also used similarly by Griffith et al. (2010), Griffith et al. (2007) and Buccirossi et al. (2009).

[16]Information is available at http//ec.europa.eu/competition/ecn/model_leniency_programme_annex1.pdf. For the UK, I used the introduction of the legal basis for the leniency program rather than the last revisions.

[17]In particular, the leniency program of 1996 did not ensure full amnesty while the revision in 2002 added this important point.

[18]The country for which the variable is observed is excluded inside the construction of this variable.

Manifesto data (Klingemann et al. 2006). This data provides information on a country's elected political parties' position within their corresponding electoral program regarding different categories. In general, the positions of the parties are described as the percentages of quasi-sentences in which a position is mentioned in the overall program. To construct a measure for a country, this information is weighted with the voters of the parties of a country in the last election.[19] The categories relevant for this analysis are twofold. First, I use indicators for the political parties' program regarding the role of the state towards welfare programs. In particular, I use the item *Welfare State Limitation* and *Welfare State*.[20] These two indicators show a general tendency towards a free market economy and therefore awareness of the importance of free competition without cartels but are not subject to any reverse causality by the competition intensity variable. As a second type of variables for the use as an instrument, I use the item *Planned Economy* indicating how much interference by the state is desired by the political parties.[21] This variable, however, is a compound variable containing information on the political parties' position regarding market regulation, which may be subject to changes in a country's general competition intensity. Therefore, this variable is only valid as a robustness check.[22]

4.3 Further Control Variables

Several different variables are taken from the STAN database to control for variation in competition intensity. The measure used for competition intensity, the average profitability, is influenced strongly by business cycles. To control for this source of variation, I take into account national GDP taken from the OECD Reference Series.[23] First, I estimate the linear and quadratic trend in time and, secondly, use deviations from this trend, which indicate whether the business cycle is either on the upper or lower part of the trend.

An important indicator for openness of an industry is import. The STAN data provides information on this. First, absolute values of imports in an industry and secondly, import penetration,

[19] Other scholars, Buccirossi et al. (2009) in particular, use only the government's parties position, but I assume that even though the government parties can theoretically implement their position, they will consider, at least partially, what voters consider as favorable policies, because they also seek those voters which did not vote for them before. The 2006 data is enriched with the updates available at the Manifesto's project homepage. In addition, I assumed, for missing values, that a new parliament is in place for at least two years. However, all results are robust to not imposing this assumption.

[20] *Welfare* is a compound variable of the items *Social Justice* and *Welfare State Expansion*.

[21] *Planned Economy* is a compound variable of the items *Market Regulation*, *Economic Planning* and *Controlled Economy*.

[22] If the direct item *Market Regulation* is used alone, over identification tests fail in the IV estimation. The compound variable, however, seems to be a valid instrument as the potential reverse causality is limited due to the other factors.

[23] All continuous variables are measured in Billion units of national currency.

as imports divided by the overall value added, are used. Even though the import penetration is seemingly more informative, it reflects changes in both value added and imports. To capture only changes in imports, I also add the absolute value as a control variable.

Regulation of markets harm free entry and competition in markets. To control for country specific intensity on product market regulation (PMR), I use, as in Buccirossi et al. (2009), the PMR index from the OECD PMR database. It takes into account various regulations and barriers to international trade and investment (barriers to international trade, entrepreneurship, public ownership of firms, etc.). This index is measured from 0 to 6 with higher numbers indicating tighter regulation. Data is available for 1998, 2003, and 2008. As there are always 5 missing years in between, I use a linear interpolation in the years between the data points, aware that this introduces measurement errors. This implies that an interpretation has to be careful, though it still remains a proper, but imprecise control variable. In order to control for at least European changes in the product market competition I add a dummy variable controlling for the European Single Market Program in 1992. This program abolished market entry barriers and has been shown to increase competition intensity significantly in the European Union (Griffith et al. 2010).

Relevant for the competition intensity in the EU, I control for the EU east enlargement in 2004. A dummy variable is created for the EU member states to take account of this structural break, which should have an effect on competition in European Markets. Moreover, I add a dummy for the new member states, because they should be affected stronger by the EU entrance than the former European Members.

To control for non-linearities introduced by legal aspects, I use, as in Buccirossi et al. (2009), controls for the legal system and construct interactions between the legal system and the leniency program variable. The classification of legal systems follows La Porta et al. (2008) and subdivides legal systems into those of English, French, German and Scandinavian origin. The intuition behind this is that legal instruments, as the leniency program, depend systematically on the underlying legal system. Therefore, this variable allows to capture some of the general, underlying mechanisms important for the efficiency of leniency programs.

4.4 Descriptive Statistics

Table 1 shows which countries adopted leniency at what time. The first country adopting a leniency program was the US. After this, it took five years until the next country, the UK introduced a national leniency program in 1998 as well. However, in 1996, all European Unions

(EU) member states have been affected by the first supra national leniency program. Beginning with the year 2000, the adoption rate of national leniency programs increased. Importantly, the EU revised its leniency programs substantially in 2002. However, due to the EU enlargement in 2004, some countries were affected by the EU leniency program starting then.

Table 2 provides information on the countries for which we have sufficient information within the data to provide estimates.[24] It can be observed that the distribution of observations is relatively similar across countries, with small countries as Luxembourg, New Zealand and Portugal as well as transformation countries as Hungary and Poland having less observations than the average. Some OECD countries are missing in the estimation due to missing data (i.e. Australia, Slovak Republic). Table 3 contains the industries used for estimations and shows clearly a dominance of the manufacturing industries. This dominance is due to data availability and missing values for service sectors.

Table 4 shows the main variables for one of the largest estimation samples. The average profitability has the size of 1.23 but a rather large standard deviation. It has to be noted that data shows, as in Griffith et al. (2010), an increasing tendency of the average profitability/PCM over time.[25] This upward trend is not a significant problem as I am interested in differentials. Moreover, due to its upward trend, it is possible that there is an underestimation of the possibly negative impact of leniency programs on the PCM. In 29 % of the observations,[26] a national leniency program is installed. Moreover, 56% are subject to the first EU leniency program and 31% to its revision. The OECD PMR index has an average size of 1.81. 66% of the observations are treated by the European Single Market Program, which indicates that the data consists mostly of EU member states. This can also be seen in the percentage of observations treated by the EU enlargement in 2004, which is around 21%.

5 Empirical Analysis

Table 5 provides basic estimations analyzing the impact of leniency programs on competition intensity. Column (1) shows as a baseline a pooled OLS estimation, but a significant effect of leniency programs on the PCM cannot be revealed. As this may be due to time-invariant unobservable heterogeneity, column(2) provides a fixed effects estimation. There is a significant impact of the national leniency program variable on the PCM (coeff. -0.0352, std. error 0.0182).

[24] For Australia and the Slovak Republic, not all necessary variables are non-missing.

[25] This pattern has been observed by other authors as well (i.e. Blanchard and Giavazzi 2003). They propose that a decreasing bargaining power of workers may be one reason for this.

[26] An observation is defined as values of a specific country within a specific year.

National leniency programs have been complemented in the EU by supranational leniency programs (introduction in 1996 and major revision in 2002). Column (3) adds controls for the EU program's implementation and its major revision in 2002. Estimation shows that the impact of the first European leniency program on the PCM is negative and significant (coeff: -0.1074, std. error: 0.0320), as well as its revision in 2002 (coeff: -0.0558, std. error: 0.0243). The impact of the national leniency program remains significantly negative (coeff: -0.0451, std: error 0.0181). Column (4) adds a control for neighbor countries' national leniency programs and identifies a positive, significant impact (coeff: 0.0676, std. error: 0.0260). This positive coefficient indicates that leniency programs seem to have an impact on the outcome even if implemented in neighboring countries. This may be explained by less market power of foreign input provider. The controls for the European supranational leniency programs as well as the control for the national leniency program stays strongly significant and negative. This indicates that leniency programs are positively correlated with a higher competition intensity.

Table 6 adds further factors supposed to have an impact on industries' competition intensity in order to reduce possibly omitted variable bias. Column (1) provides the baseline estimation with the national leniency program as well as the first European leniency program being significant. A major policy program which has had an impact on competition in European markets has been the European Single Market Program in 1992, for which a control is added in column (2). The effect on the PCM is negative and strongly significant and also the effect of national leniency programs stays strongly significant (coeff: -0.0492, std. error: 0.0185). Moreover, the previously found effect of the European Union's program remains negative and significant for the revision in 2002. It is not clear why the effect of the first program diminishes. This is either due to a non-existing effect or only limited variance in the variable. Column (3) considers the impact of the European Union's enlargement in 2004, which increased the European single market significantly. Moreover, the enlargement took place in the time period when national leniency programs were implemented in the EU. Therefore, it may reduce too strong of an effect of the national leniency program. In particular, it can be seen that the PCM in all EU countries, was reduced clearly and significantly. However, controlling for these variables, the significant impact of national leniency programs remains unchanged and robust (coeff: -0.0457, std. error: 0.0194). The effect of the European's supranational leniency program, however, becomes insignificant. Column (4) adds the control for the countries' particular regulation on product markets. As expected, more product market regulation leads to a higher PCM and, therefore, less competition on those markets. This effect is strongly significant at the 1% level, without affecting the strongly significant impact of leniency programs on the PCM. Results indicate that the effect of leniency programs is persistent and robust to different other factors (coeff: -0.0452, std. error: 0.0194), which have an impact on the competition intensity.

In order to test whether the previously observed and persistent effect of leniency programs can be interpreted causally, I introduce an instrumental variable regression in table 7. This approach explicitly allows to test for endogenity and omitted variable bias. Column (1) offers a basic regression with the previously used control variables. I use leniency program application in other OECD countries as an instrument and can verify the previously found negative impact of leniency programs on the PCM, or, in other words, its positive impact on competition intensity. However, the effect has double the size of the OLS estimates (coeff: -0.1029 std. error: 0.0172). The strong significance of the instrument in the first stage backs the hypothesis of the leniency implementation in other OECD countries as a proper instrument. The Wu-Hausman test provides a p-value of 87% indicating that the instrument is not necessary and that the leniency program variable is not endogenous. Therefore, this consistent estimation is not preferable to OLS, as OLS is more efficient. This inefficiency also explains the less precise coefficient, which is larger than in the OLS. Column (2) adds the first instrument of the set of the policy program instrument regarding the political parties position regarding *Welfare State*. This second instrument allows to perform over-identification tests on the validity of the instruments. Importantly, the impact of leniency programs on the PCM remains negative (coeff: -0.0734 std. error: 0.0203) and reduces the strength of the impact to approximately the same level as the OLS estimation. The Wu-Hausman test provides a p-value of 100%, clearly indicating a non endogenous relationship. The Sargan test, yielding a p-value of 59%, indicates that the instruments used are valid. Column (3) adds the second policy program variable *Welfare State Limitation*. The same impact of leniency programs on the PCM (coeff: -0.0700, std. error: 0.0202) and the Wu-Hausman test indicating a non endogenous relationship. Column (4) adds the *Planned Economy* variable to the instrumental variables with the Wu-Hausman test and the Sargan test confirming the same non-endogenous relationship between leniency programs and the PCM (coeff: -0.0694, std. error: 0.0202) as well as the validity of instruments. Taking these results into account, the relationship between leniency program implementation and the PCM can be neither denoted to be endogenous nor can it be denoted to face significant omitted variable bias, allowing a causal interpretation of the preferable OLS coefficients.[27] As a side finding, the estimations show that in the first column, the revision of the European supranational leniency program is significant but becomes insignificant afterwards. This may be explained by the imprecision of the estimates in the first column, which indicate a non significant impact of these programs.

Table 8 analyzes the importance of time lags regarding the measurement of leniency programs. This is an important test to check whether the impact of leniency programs is observable only

[27]The variable *Planned Economy* is not significant in the first stage if it is used together with the other political variables, however, it is significant without using them, indicating predictive power as an instrument. This specification is still informative as it helps to test overall validity of the instruments using the Sargan over-identification test.

in one period or persistently over time. Estimations use the full set of variables. In columns (1) to (6), the leniency program variable is used first with no time lags and then increased up to 5 years of time lag. The impact on the PCM is negative and significant for the one year lag, but seems to be stronger the more time lags are used. Results suggest that it takes a while, up to one periods after implementation, until the leniency programs are becoming effective. This is interesting as it shows that a learning time is necessary until firms react to the new program.

The effectiveness of leniency programs depends on a variety of specific conditions. One condition which has a rather strong effect is the legal environment in which a leniency program is in place. Table 9 analyzes the dependency of the legal system. As the underlying legal system is time invariant, pooled OLS estimations are used. Column (1) introduces controls for the legal system. As the baseline, I use the French legal system. It can be seen that on average, profits are lower in countries with the English and Scandinavian legal system and especially in countries with German legal systems. As in the first regression table, the pooled OLS can identify a negative, but not significant value for the national leniency program. Column (2) introduces an interaction term between the legal system with leniency programs. Results show that the impact of leniency programs is still negative and becomes significant now. However, interaction effects indicate different efficiency of leniency variables within the different legal systems. They seem to be less efficient especially in countries with English or Scandinavian legal systems. Even though it is not clear how efficient the pooled OLS estimation is, it seems to be clear that the institutional factors are important. Columns (3) and (4) add additional control variables. In column (3), the overall leniency effect gets smaller, which applies also for column (4). The patterns regarding the interaction effects stay the same. They seem to be more efficient in countries with German and French legal systems. These results indicate that leniency programs are actually not effective by themselves, but dependent on the environment where they are implemented.

6 Conclusions

This study proposed to infer efficiency of leniency programs by using the PCM as a measure of competition intensity. I argued that an increasing competition intensity indicates that leniency programs destroy cartels (either due to detection or deterrence). Empirical analysis shows that leniency programs have a robust and throughout negative impact on the PCM, which is approximately between 3 % and 5 %. This implies a positive impact on the competitive environment at the industry level. The study does not directly investigate whether this impact is due to detection of cartels or due to deterrence of cartels, but as the number of detected cartels is presumably not large enough to have an impact on a too large number of industries,

this study provides evidence that cartels are destabilized and deterred. This paper takes account of various relevant issues that may bias this finding. In the analysis, an instrumental variable approach is used to tackle the most important identification problems', omitted variable bias and endogeneity. All results are robust to various instruments and finally, no proof of endogeneity can be provided. This leads to clear support of the provided OLS estimations and backs the found evidence for effectiveness of leniency programs in the OECD countries, indicating a causal impact of leniency programs on competition intensity. This study therefore complements the previous studies on this topic, tackling, however, their main drawback of incomplete identification based on detected cartels only.

Beside this main finding, the study provides some further interesting results. I was able to show that the effect of leniency on competition intensity becomes significant one year after the implementation and increases over time. This indicates that leniency programs need some time before beoming effective. As an additional result, it can be stated that the underlying legal system in which those leniency programs can be found seem to have an important impact. Regressions indicate some correlations that may be interesting for further research on detailed conditions of leniency programs to work appropriately. As a side finding, correlations between the supranational EU leniency programs and competition intensity can be found, however, these correlations are not robust when controlling for other sources of variation in the competition intensity.

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7 Appendix

Table 1: Leniency Implementation in OECD Countries

Country	*National Leniency Program*	*Affected by 1st EU Leniency Program (1996)*	*Affected by 2nd EU Leniency Program (2002)*
Australia	2003		
Austria	2006	x	x
Belgium	2007	x	x
Canada	2000		
Czech Republic	2001		2004
Denmark	2007	x	x
Finland	2004	x	x
France	2001	x	x
Germany	2006	x	x
Greece	2006	x	x
Hungary	2003		2004
Ireland	2001	x	x
Italy	2007	x	x
Japan	2006		
Korea	2002		
Luxembourg	2004	x	x
Netherlands	2002	x	x
New Zealand	2000		
Norway	2004		
Poland	2004		2004
Portugal	2006	x	x
Slovak Republic	2001		2004
Spain	2008	x	x
Sweden	2002	x	x
Switzerland	2003		
United Kingdom	1998	x	x
United States	1993		

The Czech Republic, Hungary, Poland and the Slovak Republic joined the EU in 2004. Therefore, the EU leniency revision is only considered to be in place since 2004. The definition when a leniency program is effectively in place orients on the first reform implementing an ECN equivalent leniency program.

Table 2: Countries and Observations

Country	*Observations*	*Percent*	*Cumulative*
Austria	199	6.17	6.17
Belgium	166	5.15	11.32
Canada	111	3.44	14.76
Czech Republic	159	4.93	19.69
Denmark	200	6.20	25.89
Finland	205	6.36	32.25
France	108	3.35	35.60
Germany	188	5.83	41.43
Greece	103	3.19	44.62
Hungary	96	2.98	47.60
Ireland	135	4.19	51.78
Italy	181	5.61	57.40
Korea	70	2.17	59.57
Luxembourg	65	2.02	61.58
Netherlands	201	6.23	67.81
New Zealand	45	1.40	69.21
Norway	184	5.71	74.91
Poland	111	3.44	78.36
Portugal	83	2.57	80.93
Spain	151	4.68	85.61
Sweden	153	4.74	90.36
United Kingdom	168	5.21	95.57
United States	143	4.43	100.00
Total	3,225	100.00	

Table 3: Industries and Observations

Industry	*Observations*	*Percent*	*Cumulative*
Fishing, fish hatcheries, fish farms and related services	284	8.81	8.81
Other mining and quarrying	53	1.64	10.45
Food products and beverages	33	1.02	11.47
Tobacco products	99	3.07	14.54
Wearing apparel	176	5.46	20.00
Leather, leather products and footwear	234	7.26	27.26
Wood and products of wood and cork	261	8.09	35.35
Printing and publishing	213	6.60	41.95
Coke, refined petroleum products and nuclear fuel	5	0.16	42.11
Chemicals and chemical products	154	4.78	46.88
Rubber and plastics products	231	7.16	54.05
Other non-metallic mineral products	315	9.77	63.81
Fabricated metal products, except machinery and equipment	127	3.94	67.75
Machinery and equipment	26	0.81	68.56
Electrical machinery and apparatus, n.e.c.	160	4.96	73.52
Radio, television and communication equipment	222	6.88	80.40
Medical, precision and optical instruments	214	6.64	87.04
Other transport equipment	160	4.96	92.00
Manufacturing n.e.c.	18	0.56	92.56
Electricity, gas, steam and hot water supply	26	0.81	93.36
Research and development	17	0.53	93.89
Other business activities	185	5.74	99.63
Public admin. and defence - compulsory social security	12	0.37	100.00
Total	3,225	100.00	

Table 4: Main Variables

Variable	*Observations*	*Mean*	*Standard Deviation*
Average Profitability	3194	1.2251	0.5448
National Leniency Program	3225	0.2896	0.4537
1st European Leniency	3225	0.5678	0.4955
2nd European Leniency	3225	0.3057	0.4608
OECD PMR Index	3194	1.8136	0.5798
Single Market Program	3225	0.6636	0.4726
Leniency Program in Neighbor Country	3225	0.3021	0.3933
EU 2004 enlargement	3225	0.2121	0.4089
New EU member in 2004	3225	0.0378	0.1908
English Legal System	3225	0.1867	0.3897
German Legal System	3225	0.2552	0.4361
Scandinavian Legal System	3225	0.2301	0.4209
French Legal System	3225	0.3280	0.4696
GDP Trend	3225	1.5655	3.4795
Imports (as a share of value added)	3225	3.64e-09	2.41e-08
Imports (absolute)	3225	104.3493	1133.287

Imports and import penetration are measured in Billions of national currency. Leniency in neighbor countries is measured since 1990.

Table 5: Leniency Programs Basic Estimations

	ln(PCM) Pooled OLS (1)	ln(PCM) Fixed Effects (2)	ln(PCM) Fixed Effects (3)	ln(PCM) Fixed Effects (4)
National Leniency (2 lags)	-0.0147	-0.0352*	-0.0451**	-0.0360**
	(0.0315)	(0.0182)	(0.0181)	(0.0182)
1st EU Leniency (2 lags)			-0.1074***	-0.0840***
			(0.0320)	(0.0314)
2nd EU Leniency (2 lags)			-0.0558**	-0.0483**
			(0.0243)	(0.0226)
Leniency N. Country (2 lags)				0.0676***
				(0.0260)
GDP Trend (in logs,1 lag)	0.0229***	0.0145***	0.0137***	0.0106***
	(0.0017)	(0.0039)	(0.0040)	(0.0038)
Import penetration (in logs, 1 lag)	-0.1546***	-0.3721***	-0.3590***	-0.3400***
	(0.0178)	(0.0415)	(0.0396)	(0.0390)
Imports (in logs, 1 lag)	0.1630***	0.3039***	0.2832***	0.2578***
	(0.0207)	(0.0400)	(0.0394)	(0.0392)
Industry dummies	x			
Country dummies	x			
Time dummies	x	x	x	x
Constant	-7.9222***	-14.3401***	-13.6276***	-12.7230***
	(1.1346)	(1.6267)	(1.5744)	(1.5548)
R^2	0.4855	0.3653	0.3879	0.3877
Observations	3164	3164	3164	3064

Robust Standard errors are in brackets, Column 1's clustered in year-country dimension
*Significant at 1% ***, significant at 5 % ** , significant at 10% **

Table 6: Leniency and Competition Affecting Programs

	ln(PCM) Fixed Effects (1)	ln(PCM) Fixed Effects (2)	ln(PCM) Fixed Effects (3)	ln(PCM) Fixed Effects (4)
National Leniency (2 lags)	-0.0360**	-0.0492***	-0.0457**	-0.0452**
	(0.0182)	(0.0185)	(0.0194)	(0.0194)
1st EU Leniency (2 lags)	-0.0840***	-0.0345	-0.0090	-0.0093
	(0.0314)	(0.0257)	(0.0327)	(0.0325)
2nd EU Leniency (2 lags)	-0.0483**	-0.0515**	-0.0122	-0.0203
	(0.0226)	(0.0228)	(0.0185)	(0.0181)
Leniency N. Country (2 lags)	0.0676***	0.0484*	0.0466*	0.0465*
	(0.0260)	(0.0271)	(0.0272)	(0.0264)
Single Market Program (2 lags)		-0.2088***	-0.2218***	-0.1883***
		(0.0353)	(0.0336)	(0.0303)
EU 2004 enlargement (2 lags)			-0.1283***	-0.1115***
			(0.0435)	(0.0423)
New EU member in 2004 (2 lags)			-0.0888	-0.0601
			(0.0585)	(0.0553)
PMR Index (2 lags, in logs				0.0970*
				(0.0587)
GDP Trend (in logs, 1 lag)	0.0106***	0.0091**	0.0088**	0.0068**
	(0.0038)	(0.0038)	(0.0037)	(0.0035)
Import penetration (in logs, 1 lag)	-0.3400***	-0.3323***	-0.3360***	-0.3179***
	(0.0390)	(0.0395)	(0.0387)	(0.0390)
Imports (in logs, 1 lag)	0.2578***	0.2458***	0.2541***	0.2403***
	(0.0392)	(0.0403)	(0.0392)	(0.0394)
Time dummies	x	x	x	x
Constant	-12.7230***	-12.3108***	-12.5630***	-12.1155***
	(1.5548)	(1.5900)	(1.5523)	(1.5348)
R^2	0.3877	0.4054	0.4115	0.3974
Observations	3064	3064	3064	2918

Robust Standard errors are in brackets, Column 1's clustered in year-country dimension
*Significant at 1% ***, significant at 5 % ** , significant at 10% **

Table 7: Instrumental Variable Estimation

	ln(PCM) IV (1)	ln(PCM) IV (2)	ln(PCM) IV (3)	ln(PCM) IV (4)
National Leniency (2 lags)	-0.1029***	-0.0734***	-0.0700***	-0.0694***
	(0.0172)	(0.0203)	(0.0202)	(0.0202)
1st EU Leniency (2 lags)	-0.0215	0.0160	0.0161	0.0161
	(0.0145)	(0.0171)	(0.0171)	(0.0171)
2nd EU Leniency (2 lags)	-0.0686***	-0.0302	-0.0303	-0.0303
	(0.0161)	(0.0189)	(0.0189)	(0.0189)
Leniency N. Country (2 lags)	0.0318**	-0.0081	-0.0072	-0.0071
	(0.0150)	(0.0168)	(0.0167)	(0.0167)
Single Market Program (2 lags)	-0.2024***	-0.3139***	-0.3130***	-0.3128***
	(0.0258)	(0.0838)	(0.0838)	(0.0838)
PMR Index (2 lags, in logs	0.1472***	0.0628*	0.0619*	0.0617*
	(0.0298)	(0.0328)	(0.0328)	(0.0328)
GDP Trend (in logs, 1 lag)	0.0071***	0.0138***	0.0138***	0.0137***
	(0.0018)	(0.0023)	(0.0023)	(0.0023)
Import penetration (in logs, 1 lag)	-0.3283***	-0.3198***	-0.3195***	-0.3195***
	(0.0133)	(0.0162)	(0.0162)	(0.0162)
Imports (in logs, 1lag)	0.2496***	0.2544***	0.2543***	0.2543***
	(0.0167)	(0.0207)	(0.0207)	(0.0207)
Time dummies	x	x	x	x
Constant	-12.6408***	-11.8715***	-11.8647***	-11.8636***
	(0.6084)	(0.7462)	(0.7460)	(0.7459)
Wu-Hausman Test	0.87	1.0	1.0	1.0
Sargan Test	-	0.59	0.25	0.34
Observations	2874	1977	1977	1977

Robust Standard errors are in brackets
*Significant at 1% ***, significant at 5 % ** , significant at 10% **
Instruments used: Column (1) OECD Leniency, Column (2) + Welfare State
Column (3) + Welfare State Limitation, Column (4) + Planned Economy

Table 8: Leniency and Timing

	ln(PCM) Fixed Effects (1)	ln(PCM) Fixed Effects (2)	ln(PCM) Fixed Effects (3)	ln(PCM) Fixed Effects (4)	ln(PCM) Fixed Effects (5)	ln(PCM) Fixed Effects (6)
National Leniency	-0.0266					
	(0.0162)					
National Leniency (1 lag)		-0.0264*				
		(0.0158)				
National Leniency (2 lags)			-0.0452**			
			(0.0194)			
National Leniency (3 lags)				-0.0563***		
				(0.0207)		
National Leniency (4 lags)					-0.0750***	
					(0.0213)	
National Leniency (5 lags)						-0.1063***
						(0.0271)
1st EU Leniency (2 lags)	-0.0075	-0.0069	-0.0093	-0.0165	-0.0317	-0.0877**
	(0.0326)	(0.0325)	(0.0325)	(0.0325)	(0.0332)	(0.0342)
2nd EU Leniency (2 lags)	-0.0229	-0.0210	-0.0203	-0.0259	-0.0223	-0.0148
	(0.0194)	(0.0187)	(0.0181)	(0.0178)	(0.0186)	(0.0180)
Leniency N. Country (2 lags)	0.0585**	0.0535**	0.0465*	0.0421	0.0498*	0.0665***
	(0.0260)	(0.0257)	(0.0264)	(0.0264)	(0.0254)	(0.0242)
Single Market Program (2 lags)	-0.1807***	-0.1855***	-0.1883***	-0.1922***	-0.1795***	-0.0922***
	(0.0305)	(0.0304)	(0.0303)	(0.0304)	(0.0291)	(0.0244)
PMR Index (2 lags, in logs	0.0796	0.0833	0.0970*	0.1035*	0.0932	0.0586
	(0.0573)	(0.0563)	(0.0587)	(0.0591)	(0.0587)	(0.0575)
EU 2004 enlargement (2 lags)	-0.0924**	-0.1022**	-0.1115***	-0.1018**	-0.0925**	-0.0691*
	(0.0390)	(0.0394)	(0.0423)	(0.0401)	(0.0384)	(0.0357)
New EU member in 2004 (2 lags)	-0.0869	-0.0788	-0.0601	-0.0312	-0.0069	0.0632
	(0.0538)	(0.0541)	(0.0553)	(0.0555)	(0.0536)	(0.0556)
GDP Trend (in logs, 1 lag)	0.0063*	0.0065*	0.0068**	0.0062*	0.0074**	0.0088**
	(0.0034)	(0.0034)	(0.0035)	(0.0036)	(0.0035)	(0.0035)
Import penetration (in logs, 1 lag)	-0.3156***	-0.3159***	-0.3179***	-0.3195***	-0.3230***	-0.3188***
	(0.0390)	(0.0390)	(0.0390)	(0.0390)	(0.0392)	(0.0414)
Imports (in logs, 1 lag)	0.2369***	0.2379***	0.2403***	0.2426***	0.2447***	0.2517***
	(0.0396)	(0.0396)	(0.0394)	(0.0395)	(0.0395)	(0.0416)
Time dummies	x	x	x	x	x	x
Constant	-11.9562***	-11.9913***	-12.1155***	-12.2097***	-12.3134***	-12.2211***
	(1.5402)	(1.5399)	(1.5348)	(1.5339)	(1.5347)	(1.6178)
R^2	0.3950	0.3949	0.3974	0.4085	0.4083	0.3972
Observations	2918	2918	2918	2874	2876	2725

Robust Standard errors are in brackets, Column 1's clustered in year-country dimension
*Significant at 1% ***, significant at 5 % ** , significant at 10% **

Table 9: Leniency Programs and the Legal System

	ln(PCM) Pooled OLS (1)	ln(PCM) Pooled OLS (2)	ln(PCM) Pooled OLS (3)	ln(PCM) Pooled OLS (4)
National Leniency (2 lags)	-0.0147	-0.0867***	-0.0823***	-0.0519***
	(0.0315)	(0.0255)	(0.0238)	(0.0174)
English Legal System	-0.9227***	-0.9322***	-1.2545***	-1.2435***
	(0.0496)	(0.0522)	(0.0970)	(0.0937)
German Legal System	-1.4661***	-1.4536***	-0.8634***	-0.8575***
	(0.2408)	(0.2362)	(0.0684)	(0.0671)
Scandinavian Legal System	-0.8358***	-0.8954***	-1.8812***	-1.8790***
	(0.0985)	(0.1023)	(0.0651)	(0.0648)
Eng. Legal Sys. x Leniency		0.0649**	0.0240	-0.0153
		(0.0277)	(0.0312)	(0.0319)
Ger. Legal Sys. x Leniency		-0.0216	-0.0207	-0.0676
		(0.0480)	(0.0599)	(0.0773)
Sca. Legal Sys. x Leniency		0.2913***	0.2602***	0.2321***
		(0.0580)	(0.0520)	(0.0464)
PMR Index (2 lags, in logs)			0.0692	0.0684
			(0.0517)	(0.0515)
Single Market Program (2 logs)			-0.2123***	-0.1888***
			(0.0456)	(0.0524)
EU 2004 enlargement (2 lags)			-0.0292	0.0294
			(0.0286)	(0.0236)
New EU member in 2004 (2 lags)			-0.0057	0.0288
			(0.0667)	(0.0873)
1st EU Leniency (2 lags)				-0.0034
				(0.0342)
2nd EU Leniency (2 lags)				-0.0660**
				(0.0243)
Leniency N. Country (2 lags)				0.0563
				(0.0353)
GDP Trend (in logs, 1 lag)	0.0229***	0.0227***	0.0214***	0.0213***
	(0.0017)	(0.0017)	(0.0018)	(0.0018)
Import penetration (in logs, 1 lag)	-0.1546***	-0.1535***	-0.1534***	-0.1528***
	(0.0178)	(0.0178)	(0.0156)	(0.0157)
Imports (in logs, 1 lag)	0.1630***	0.1643***	0.1646***	0.1628***
	(0.0207)	(0.0202)	(0.0192)	(0.0199)
Industry dummies	x	x	x	x
Country dummies	x	x	x	x
Time dummies	x	x	x	x
Constant dummies	-6.4561***	-6.4750***	-6.2754***	-6.2271***
	(0.9089)	(0.8958)	(0.7649)	(0.7808)
R^2	0.4855	0.4908	0.4951	0.4959
Observations	3164	3164	2918	2918