Preißler-Jebe, Jan Hendrik; von Blanckenburg, Korbinian; Geist, Alexander

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Comparing Cartel Behavior: A Simulation Analysis with the System of Cartel Markers (SCM)

Jan Hendrik Preißler-Jebe*
Korbinian von Blanckenburg
Alexander Geist

Abstract

This work simulates the behavior of a price, quota and regional cartel in terms of indicators such as price, capacity and rate of return. As a first step the specific behavior patterns of each cartel are indicated in a graphical analysis before a comparison to a competitive benchmark has been implemented. In a second step simulation data has been applied to the System of Cartel Markers (SCM) invented by Blanckenburg and Geist. The SCM uses empirical correlation and stationarity of indicators to provide empirical evidence for cartel behavior. For the simulated cartel data the SCM delivered consistent results which underline its functionality for simulation purposes.

*Corresponding Author: maditzen@hotmail.com

1. Introduction

"People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public or in some contrivance to raise prices."[1]

What *Adam Smith* pointed out precisely more than 150 years ago, can continuously be observed in articles on prosecuted cartels in nowadays newspapers around the globe.
This work is a contribution to the further development on detecting cartels through empirical evidence. It applies the System of Cartel Markers, SCM, on simulated cartel data to illustrate a method of detecting cartels through market process patterns which can be observed during market disequilibria.
Previous approaches on cartel detection where always based on comparative-static equilibrium models, for example see *Harrington* (2006). But static equilibrium models face a certain weakness - their assumptions. It is assumed that after a short adjustment period markets always return to equilibrium. An existing cartel however, will cause disequilibria of supply and demand on a market, which could be miss interpreted through a static model as a new equilibrium, after an adjustment period. Such problems will be avoided once one refuses the assumption, that through adjustment, markets will always lead them self to short or mid-term equilibrium.[2]
One should rather consider a market process model, modelling disequilibria and so the deviation from cartel and competitive pricing enforced by the cartels capacity under utilization. Such a model has been founded by *Grossekettler* (1985) for industrial economic purposes. The model distinguishes five different interacting processes: market clearing, rate of return normalisation, superiority erosion, and product and operations process. Those processes can be described as control loops which are used to conclude from a negatively regenerated control variable (for example "excess demand" $x^e = x^d - x^s$) and a manipulated variable (for example "price change" Δp) to a competitive equilibrium after several adjustment rounds (within a ending time horizon t).

[1] *Smith, A.* (1840).
[2] *Samuelson, P.A* (1941).

This so called "Coordination Failure Diagnostics" concept has been further developed by *Grossekettler(2009a)* and his students in order to show the above mentioned processes in reality time series. *Blanckenburg* (2009) demonstrated how the regenerating parameters can be econometrically determined. He developed a pattern that allows measuring the dynamics of market actions and subsequently evaluating its functionality. *Geist* (2010) demonstrates this, in his results for the German chemical industry.

This work however will use the indicators determined within the market clearing and rate of return normalization process for cartel simulation. The market clearing process aims for a permanent equalized supply and demand relation on a market to prevent first, time lags in delivery and stock shortages caused by an excess demand and second, the inefficient use of resources through overproduction and so excess quantities in stock caused by excess supply.

According to *Dönnebrink* (1994) and *Lorenz* (2006) the market clearing process can be seen as a short term process since it focuses on variables (indicators) such as price, price change and capacity utilisation deviations which tend to be rather volatile over time[3].

The rate of return normalization process aims for minimization of positive and negative rate of return deviations as a cause of capacity utilisation. Capacity adjustments in production should only be justified in case of efficiency improvements in production process.

In opposite to the market clearing process the rate of return normalisation process can be seen as a long term processes, since capacity adjustments and so rate of return changes tend to have a rather longer time horizon then price changes[4].

Previous experiences with such empirical market processes have shown that the appearance of disequilibria is much more common than actual equilibriums and that market processes are a lot slower as comparative-static models implicit them to be. This causes empirical correlation which now can be used for cartel detection. In general, one can say that every cartel leaves its marks on each by *Grossekettler* introduced market processes (like the tendency for a permanent capacity underutilization). This leads to *Grossekettlers* description of a "cartel syndrome" characterized by "cartel markers" which shows the negative effects on each of the above named processes for the economy during cartel activity (For example the waste of capacity). Once a marked shows these "cartel syndromes" one can conclude by the "disease syndromes" the probability for a hidden cartel. On this base *Lorenz* (2006) developed a market screening for hidden cartels. *Blanckenburg* and *Geist* have further developed *Lorenz* idea by introducing markers which relate to the M- and R- process and so created "The System of Cartel Markers" (SCM). The SCM can be seen as a testing method, detecting

[3] For further description see *Grossekettler* (2009b).
[4] For further description see *Grossekettler* (2009c).

collusive behaviour through markers within the M and R process. It is also able to classify whether the cartel is just in its formation phase or already an established cartel. The distinction is needed since single process patterns in each phase require a different interpretation. So far, the SCM includes prices, capacity utilization, rates of return and capacity growth rates as markers. *Blanckenburg* and *Geist* (2010)

The structure of this paper will be as followed first, an approach to generalize and distinguish between different cartel types, second to simulate different cartel types during "market clearing" and "rate of return normalisation" process and third to prove the during the simulation received results through the SCM testing method.

2. Introduction and description of cartel types

2.1 General alleged cartel behaviour

"If a large number of producers wish to escape the rigors of competition, they must do so by forming an agreement to act together (called a cartel, after their German name) or by actually merging into one firm."[5]

Throughout the literature one will find the oligopolistic markets as typical cartel markets where a few companies supply the whole marked. Ideally such a market is a competitive market, where the marginal costs are equal to the price paid and only short term disequilibria can be observed since the marked strives after short adjustments for equilibriums of supply and demand. However, what characterizes oligopolistic markets in general is the homogeneity level of the supplied goods. A high homogeneity level creates a lack of substitution between goods, which increases the possibility of abuse by market participants to increase prices or assert supply shortages because of the not existing substitution possibilities of the customers. Examples fur such goods are concrete or fertilizer, *Dönnebrink* (1994, p. 26).

Another market given or unconsciously governmentally promoted reason for establishing a cartel would be low price elasticity in demand for a certain good. In such case, a price increase by the cartel, would have to be accepted by demanders, since goods with a low price elasticity of demand tend to have hardly any substitution possibilities to avoid the price

[5] See. *Stiegler,* (1987), page 230.

increase. Such market circumstances facilitate collusive behaviour and may lead to a cartel market.

Cartels may also be facilitated through market entry barriers such as high entry investments which are likely to be irreversible. This makes is harder for new comers to enter the market since in case of failure of the market entry the new comer's entry costs become sunk costs. *Connor* (2007) states an overview of such entry barriers.

Also to mention is the importance of a high market share in order to establish a working cartel *Dönnebrink (*1994). Through collusion gained market share regulates the power of non cartel market participants.

If the cartel achieves a rather insignificant market share, it will hardly be able to enforce prices above competition level, and so not be able to stay on the market. In general, one can say that cartels abuse certain market circumstances to pursuit a utility increase which will be revealed by higher revenues compared to a competitive benchmark.

It is also due to the market circumstances what kind of a cartel will develop on the particular market. *Dönnebrink* (1994) relates the cartel type to the parameter which makes companies merge to a cartel. As an example *Dönnebrink* states, price, terms, standards or discount cartels. However, one should also take into account that cartels originate on a broader level, which leads subsequently to production-quota and regional cartels. This work focuses on price, quota and regional cartels which will be simulated in section 3, after each type is introduced and distinguished in the following section.

2.2. Description of cartel types

2.2.1 Type 1: Price cartel with collusive investment behaviour

Following *Tirole* (1988) the members of a price cartel only aim for rate of return and price increases for their own good. Through their cartel formation, they strive to realize monopolistic rents by Cournot-prices and quantities which create a consumer excess burden. This underlines the fact that the main issue for the impact of a price cartel is the determination of a price parameter. The price parameter has to be set in a way that every cartel member is accepting it; otherwise the stability of the cartel is threatened. Among the price parameter the cartel has to maintain an investment policy within its members. This ensures that each member only supplies the amount of goods he is allowed by the cartel and does not expand his capacities since such behaviour would ultimately lead to a supply increase, followed by a decrease in price and so to an unstable situation within the cartel which could cause its end.

Also to mention is the importance of a high market share in order to establish a working cartel. The through collusion gained market share regulates the power of non cartel market participants.

Concerning both above introduced control loops, in a price cartel the **market clearing process** can be observed trough the markers, price (price changes) and capacity utilisation.

In the formation phase, the first step of a cartel would be to announce a binding **price** above the competition level to its members that each member has to accept. It is likely that the cartel continues to raise its prices until it reaches a price as close to the cournot price as possible. The further pricing behaviour of cartels would show a quiet static behaviour in terms of adjusting prices to exogenous shocks. Such behaviour follows the cartels lag of coordination, to react quickly to demand deviations, *Blanckenburg, Geist and Kholodilin* (2010, page 8)[6]. This becomes reflected through a "staircase-shaped" distribution of the cartels absolute prices during the cartel phase.

Observing the distribution of relative price changes one will notice that, compared to competitive pricing behaviour, there are a lot fewer price changes (more zero-changes) during the cartel phase. The reason for this is again, the static behaviour to react to exogenous shocks, once the cartel is established.

The above assumed investment restriction within the cartel determines basically fixed capacities. Since the cartel strives for monopolistic rents it will shorten the quantity supplied during "formation phase", which is simply creating a situation of **unutilized capacities** in order to reach quantities which maximize their monopolistic rents.

During "cartel phase" those unutilized capacities disable market equilibriums, since a normal rate of demand will always face a shortage of supply.

Analysing the **rate of return normalization process** the focus is on markers such as capacity growth rate changes and rate of return difference. In the short run collusive behaviour is drawn by higher prices and supply shortages. In the long run, one can observe further parameters which indicate collusive behaviour such as capacity deviations and rate of return bias. As an example can be seen a positive demand shock; in the long run on a competitive market, companies will invest in further capacities to cover the excess demand. Cartels, however, would not have to take such investments. Through their assumed behaviour of seeking for Cournot prices and quantities by capacity underutilisation, they have built up excess capacities over time, which they will use to cover the increased demand. *Benoit and*

[6] *Geroski and Jacquemin (*1988*)* deliver empirical support for this hypothesis.

Krishna (1987) state that on a long perspective all collusive equilibria involve excess capacities.[7]

Thinking of a **capacity growth rate change** marker during formation and cartel phase, one would assume growth rate changes on a zero level. This goes back to the just above mentioned behaviour of a cartel. The existing excess capacities do not force a cartel to invest in new capacities in case of exogenous shocks. The only exception would be if the market originates a permanent higher demand level. Then it would be essential for the cartel to build up new capacities in order to obtain its power.

The third marker **rate of return difference** is probably the most common marker to detect collusive behaviour, *Bresnaham* (1991)**.** However, it is also the one where the reasons for deviations are hardest to exactly identify.

In order to use this marker**,** a sufficient value has to be determined which states if the level of the rate of return difference for a certain firm is justified or not. This can be done through a comparison to the rate of return difference of the industry the firm operates in.

During the whole cartel phase excess rates of returns are expected since they are the reason for formation and continuance of the cartel. Dividing such excess rate in two phases, a conspicuous increases of rate of return difference during "formation phase" and a certainly higher level of rates of return during "cartel phase" could be expected.

But, one may also find problems identifying deviations of the rate of return difference, caused by other parameters which influence it. For instance, excess rates of return can also be the result of high market concentration of a company, which gains its high margins through economies of scale. See *Blanckenburg and Geist* (2010)**.**

However one has to carefully evaluate the observed data in order to judge if high rates of return are caused by collusive behaviour or if there happen to be other marked given reasons.

[7] *Osborne and Pitchick* (1987) support this assumption.

Table 1: Summary of alleged price cartel behaviour

		Formation Phase	Cartel Phase
M-Process	**Price changes**	Suddenly exceptional increase of prices compared to a competitive benchmark Stair case shaped	Conspicuously few positive or negative delayed price adjustments on a certainly higher level compared to the competitive benchmark
	Capacity utilization rate	Reduction of supplied quantities creates a decrease in capacity utilization	In average continuously underutilized capacities
R-Process	**Capacity growth rate changes**	Changes on a zero level due to underutilized capacities	
	Rate of return difference	Increase of rates of return, compared to a broader industry	Continuously excess rates of return are expected.

2.2.2 Type 2: Quota cartel without collusive capacity changes

The second cartel type we distinguish is a quota cartel without collusive capacity changes.

In terms of price and supply behaviour, such a cartel type has its origin in a price cartel *Lorenz* (2006).This concludes that for this analysis the behaviour of the quota cartel during "Formation" and "Cartel phase" can be assumed equal to the above explained behaviour of a price cartel.

However the quota cartel distinguishes itself from a price cartel through the distribution of revenues. Revenues are being determined through a production quota which regulates the amount of goods supplied by the member to the market.

The quotas each member receives can be on one hand linked to current existing capacities of the member or on the other hand to the efficiency of the production cost function. Members with low costs receive a higher quota, but have to give compensation payments to members with higher costs, *Schuman, Meyer, Ströbele* (1999).

However collusive determination of production quotas will not only be found for market members. One will also find industries with federal determined production quotas[8].

This work focuses only on illegal quotas based on existing capacities.

To illustrate the expected influence of the quota cartel on the markers within the M- and R Process the "Cartel phase" in *Table 1.1* has to be subdivided in two phases. The behaviour of the quota cartel during "Formation phase" and the former "Cartel phase" (now "Cartel Phase I") can be seen as identically to the behaviour of the price cartel. The newly added "Cartel Phase II" points out the speciality of the quota cartel. Since the amount of revenue is linked to current capacity, each member would have an incentive to increase his capacities over time to achieve higher revenues[9]. This means for the **Capacity growth rate change** marker after changes on a zero level during "Cartel phase I" one would assume increasing capacity growth rate changes during "Cartel phase II" in order to increase the current revenues.

As a result of extended capacities in "Cartel phase II" the **Capacity utilisation rate** marker is expected to show a further decrease of the capacity utilisation rate compared to the already underutilized capacities during "Cartel phase I".

Those extended capacities should also have a significant influence to the **Rate of return difference** marker. While continuously excess rates of return were expected during "Cartel phase I", the costs for the capacity extensions lead to a decrease on a zero level for the rate of return difference during "Cartel phase II". The **price changes marker** is assumed not be affected during "Cartel phase II".

[8] *Brown and Martin* (1996) reveal the U.S." Flue-Cured Tobacco Policy "as a federal quota cartel.
[9] See *Fear* (2006).

Table 2: Summary of alleged quota cartel behavior

		Formation Phase	Cartel Phase I	Cartel Phase II
M-Process	**Price changes**	Suddenly exceptional increase of prices compared to a competitive benchmark Stair case shaped	Conspicuously few positive or negative delayed price adjustments on a certainly higher level compared to the competitive benchmark	—
	Capacity utilization rate	Reduction of supplied quantities creates a decrease in capacity utilization	In average continuously underutilized capacities	Decreasing utilisation rate through violation of the cartel restrictions through capacity extensions.
R-process	**Capacity growth rate changes**	Changes on a zero level due to underutilized capacities		Increasing capacity growth rate changes aiming for higher revenues through quota extension
	Rate of return difference	Increase of rates of return, compared to a broader industry	Continuously excess rates of return are expected.	Decreasing to a zero level, because of cost increases due to capacity extensions

2.2.3 Type 3: Regional cartel

The third observed cartel type is a regional cartel. It can be specified through a territorial marked separation, where each member of the cartel can act as a monopoly supplier who enforces cournot prices and quantities in his assigned territory. A regional cartel for example can be operating global[10], country wide or regional[11]. It just depends on, in what kind of region the cartel chooses to operate in. One will observe unequal prices for the supplied good on each assigned territory, which states price discrimination as the second negative outcome of a regional cartel, *Lorenz* (2006)

The formation of a regional cartel can be emerged through a new product, a new patent, or licensed contracts which create an exclusive supplier situation. *Lorenz* (2006).

For the markers within the M and R-process, the same behaviour as seen during price cartel "Formation Phase" and "Cartel Phase" is assumed for the regional cartel. The only exception is that during "Formation" and "Cartel Phase" **price changes** would now be observed without

[10] For an example of a global operating cartel see: *Harrington* (2006), p. 23.
[11] *Schiersch and Schmidt-Ehnke* (2010) reveal examples for national and regional cartels.

delays in opposite to the price and quota cartel. The reason for such disappearing delays could lie within the structure of the regional cartel. It is assumed that every member is acting like a monopoly in his territory, so that each single one will not have to face any price negotiations with other cartel members. Such circumstance would abandon the further above mentioned delays in price changes.

However to point out the speciality of the regional cartel the "Cartel phase" again has to be split into "Cartel Phase I" and "Cartel phase II" simultaneous to the quota cartel. Now the speciality within the regional cartel lies within the behaviour of downsizing existing capacities for an increase of revenues once the cartel member feels that his market power is unthreatened. This would cause decreasing **Capacity growth rate changes** during "Cartel phase II" while during "Phase I" changes on a zero level are expected.

Such a downsizing of capacities would ultimately create an increase of the **capacity utilisation rate** in "Phase II" until a new targeted capacity utilisation level is reached. From there one would expect changes around this new utilization level.

Finally also the **rate of return difference** marker in "Phase II" would be influenced by downsized capacities through cost reduction and efficiency improvements. Therefore a further increase of the rate of return level compared to "Cartel phase I" is assumed until a new maximum rate of return, based on the new capacities, is reached.

Table 3: Summary of alleged quota cartel behavior

		Formation Phase	Cartel Phase I	Cartel Phase II
M-Process	**Price changes**	Suddenly exceptional increase of prices striving for a cournot level, compared to a competitive benchmark	Conspicuously few positive or negative price adjustments on a certainly higher level compared to the competitive benchmark	Continuously few positive or negative price adjustments on a certainly higher level compared to the competitive benchmark
	Capacity utilization rate	Reduction of supplied quantities creates a decrease in capacity utilization	In average continuously underutilized capacities	Increase of capacity utilisation rate, which is due to the decreased capacity. Increase until utilization rate changes on a zero level can be observed
R-Process	**Capacity growth rate changes**	Changes on a zero level due to underutilized capacities		If the cartel feels unthreatened, a downsizing of existing capacity is expected
	Rate of return difference	Increase of rates of return, compared to a broader industry until the maximum rate of return under the existing capacities is reached.	Continuously excess rates of return are expected.	Further increase of rates of return due to the new downsized capacities until the maximum rate of return is reached

2.2.4 Competitive Market

As a benchmark to the just described cartel types, a competitive market is chosen. The market can be seen as totally contestable, with no market entry barriers. Further is assumed that after a short adjustment period, the market will always return to equilibrium of supply and demand. The market allows fully transparency, about product quality and price. The price for the supplied good is equal to the marginal costs.

For the markers within the M and R-process, the following behavior is expected during the whole study.

Throughout the time horizon many **price changes** with a high distribution are expected, since the suppliers are able and willing to react to demand changes quiet quickly in order to sell their supplied quantities.

The **capacity utilization rate** is also expected to react quickly to demand changes with a high distribution.

For the **capacity growth rate**, changes around zero level are expected, while most capacity changes can be explained through market entries and exits, one hast to take in to account, that in reality autonomous capacity growth rates occur which will be neglected for this study.

Also regarding the **rate of return difference,** changes on a zero level are expected, since the price equals marginal cost assumption hardly allows any revenues.

3. Simulation of Cartel Types

3.1 General

In order to proof the above made assumptions for the each marker within the M and R-process, each cartel type will become simulated through a self made data panel. *(See table II, III and IV appendix)*. In the end a competitive benchmark will be simulated in order to create a comparison between cartel and competitive marked behaviour[12].

The created data states price indices from a fictional industry. Beginning with p=100 as base year, it pictures absolute and relative change rates of the assumed prices. The time horizon the data has been simulated goes over 12 years, while changes have been taken into account on monthly bases. This totals 144 month of observation points.

As explained in section 2, the observed time horizon will be separated into different phases to analyze and point out the behaviour and specification of each cartel type.

3.2 Type I: Price cartel

3.2.1 Simulation of price change

Regarding the price cartel the following behaviour of the price change marker was expected in the description of the cartel type above.

- A cartel increases its prices striving for the cournot level.
- Static and delayed behaviour by adjusting prices to exogenous shocks
- Few price changes during cartel phase
- "Staircase-shaped" distribution of prices

[12] *Rudolph* (2009) examined through simulation the stability of the M and R-process.

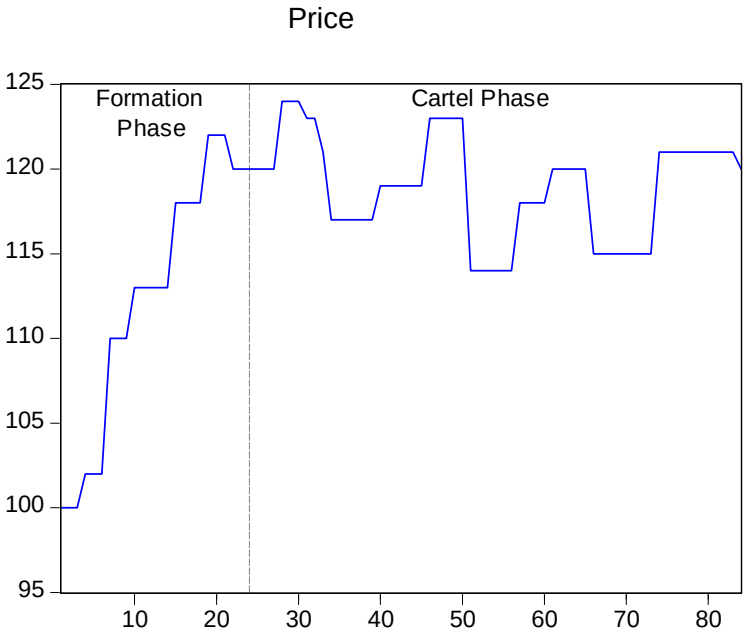

Figure 1, Price indices, Price cartel

Looking at Figure 1 which shows the absolute price data throughout the observed time horizon, beginning in period zero where (p) equals 100, one will observe a high and jumpy increase of the cartel price until a certain level is reached. It can be assumed that the point where the increase stops, the cartel has reached its aimed cournot level. Such a development is the first evidence for a price cartel in the described "Formation phase". Continuing the observation from that point, the actual "cartel phase" begins. One can clearly see that from there on, to the end of observations, prices changes occur but with a certain delay. This can be seen through a rather static behaviour of price changes compared to a more volatile behaviour of the price changes on a competitive market (3.5.1). The reason for such behaviour lies within the cartels lag to react quickly to exogenous demand changes. The plot also underlines the assumption of fewer price changes during cartel phase which is on one hand due to the lag of reaction and on the other hand to the market power the cartel has achieved through is collusion which makes it more resistant to exogenous shocks.

Along and as a cause of those mentioned characteristics, the whole plot pictures clearly a "staircase shaped" distribution of prices over the whole time horizon, as it was assumed above.

3.2.2 Simulation of capacity utilisation rate

For the capacity utilization rate marker the following assumptions have been made:

- Suddenly shortage of supply during “formation phase”

- Underutilized capacities create supply shortages to assert the higher prices

- Cartel level of capacity utilization rate disables market equilibriums during „cartel phase“

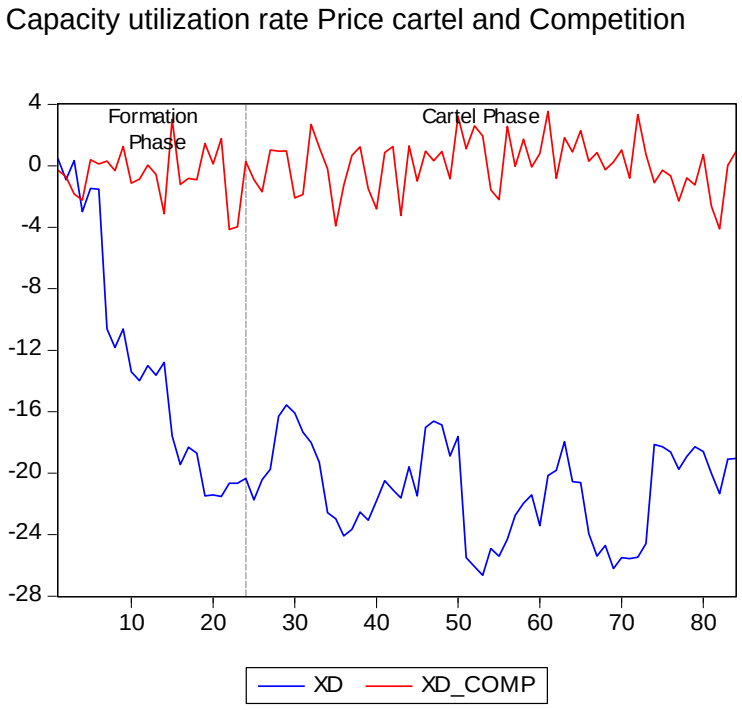

Figure 2, Capacity utilization rate, Price cartel and competition

Figure 1.1 shows the capacity utilization rate changes for a price cartel within the observed time horizon together with the capacity utilisation rate changes for a competitive bench mark. During “formation phase” a heavy decrease of capacity utilization rate can be observed which indicates a supply shortage, as assumed above. Comparing the capacity utilisation rate during “formation phase” with the price change behaviour during “formation phase” (Figure 1) one finds a clear correlation between an increase in price and a shortage in supply.

Comparing now the capacity utilization rate changes from a price cartel and competitive benchmark during “cartel phase”, the plot shows a clear level deviation created by the cartel. This proofs the assumption of cartels disabling marked equilibriums, and so creating welfare losses.

3.2.3 Simulation of capacity growth rate changes

The assumptions for the capacity growth rate changes marker during a price cartel where:

- Growth rate changes on a zero level during “formation” and “ cartel phase”

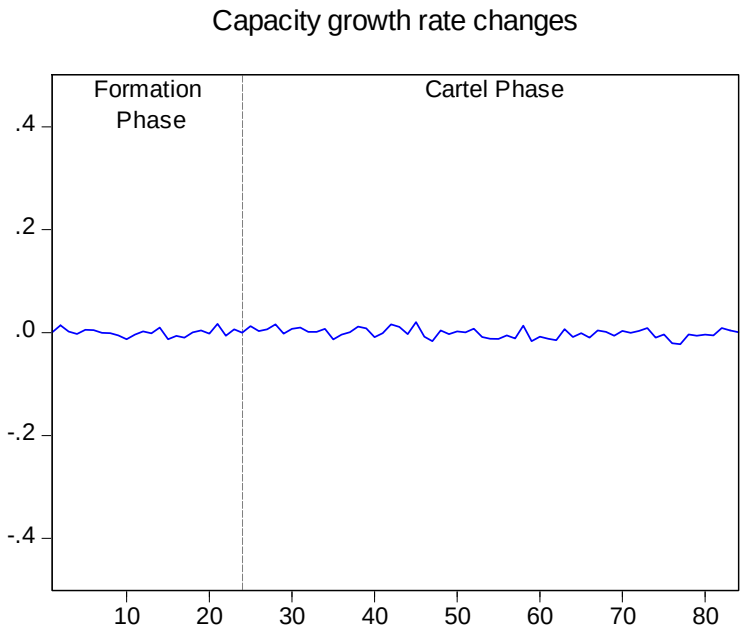

Figure 3, Capacity growth rate changes, Price cartel

Figure 3 shows clearly the above assumed behaviour of the capacity growth rate changes during the observed time horizon. Again, changes on a zero level occur because, already existing capacities are assumed fixed in a price cartel which prevents further investments in capacity in order to maintain cartel stabilisation.

3.2.4 Simulation of rate of return difference

For the last marker, rate of return difference, was assumed:

- Increasing rates of return during “formation phase”
- A higher level of rates of return compared to a broader industry

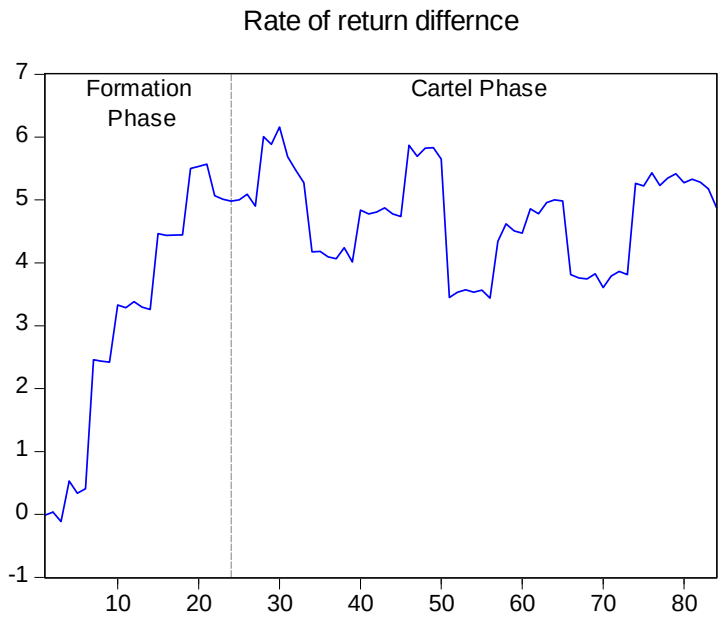

Figure 4, Rate of return difference, Price cartel

Looking at Figure 4, the assumed increase of the rate of return difference can be observed during “formation phase” through an increase of about five percent points. The rate of return difference has its origin in prices and supplied quantities which are described by the price change and capacity utilisation rate marker. This concludes that the observed increase can be explained through the simultaneous increase of price changes, and decreasing capacity growth rate changes.

The expected higher level of rate of return difference compared to a broader industry can be clearly observed from the beginning to the end of the “cartel phase”. The rate of return level of a boarder industry instead would have been found fluctuating around a zero level.

3.3 Type II: Quota cartel with collusive investment behaviour

As also done in the description of the quota cartel (2.2.2), the behaviour in "cartel phase II" is the focus of the quota cartel simulation analysis. Therefore the results for "formation phase and "cartel phase I" can be neglected since they are similar to the results of the above described prise cartel results. Also the price change marker will be neglected in this analysis since it has a rather insignificant influence to the behaviour of a quota cartel. For a closer analysis of the "cartel phase II" the observation sample has been extended to a total of 144 observation points.

As assumed above, the speciality of the quota cartel lies within the extension of existing capacities. Therefore the simulation results of the capacity growth rate change marker are the first to be examined.

3.3.1 Simulation of capacity growth rate changes

For the behaviour of the capacity growth rate change marker was assumed:

- During "cartel phase II" increasing capacity growth rate changes

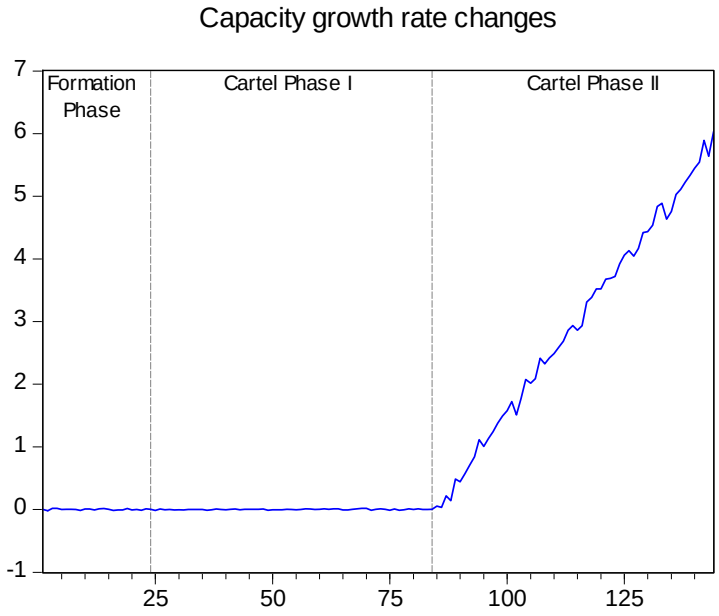

Figure 5, Capacity growth rate changes, Quota cartel

Looking at figure 5, one can observe a steady increase of the capacity growth rate change, which proofs the alleged behaviour of capacity extensions in order to achieve higher revenues within the quota cartel.

3.3.2 Simulation of capacity utilization rate changes

Since it was assumed that capacity growth rate changes directly influence capacity utilisation rate changes, it makes sense to next examine its impact on the capacity utilisation rate changes.

For the capacity utilisation rate marker was assumed above:

- Further decrease during "cartel phase II"

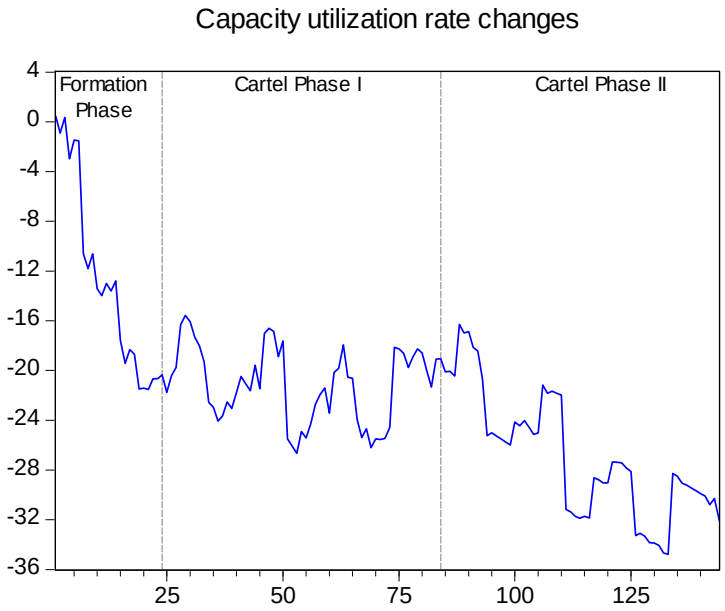

Figure 6, Capacity utilization rate changes, Quota cartel

As expected, in figure 6 the capacity utilisation rate shows even a further decrease during "cartel phase II", while already underutilized capacities where observed during "cartel phase I". Such behaviour proves clearly the assumed correlation between the two markers.

3.3.3 Simulation of rate of return difference

The third marker where an influence of capacity extensions was expected is the rate of return difference marker.

For the rate of return difference marker was assumed above:

- Decreasing rates of return to a zero level during “cartel phase II”

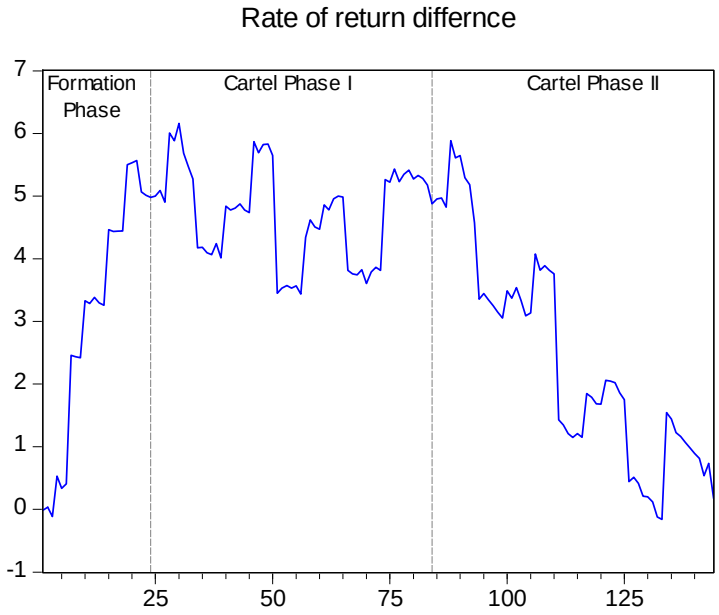

Figure 7, Rate of return difference, Quota cartel

Also figure 7 proves the above made assumptions regarding the behaviour of the rate of return difference marker in a quota cartel. One can observe a moderate decrease of the rate of return to a zero level during “cartel phase II”. Comparing now figure 5 and 7 it is decisive that once the cartel begins to extend its capacity it causes a reduction of the rate of return. This correlation is due to the extra costs of the capacity extensions which cause a negative impact on the rate of return difference.

3.4 Type III: Regional Cartel

For the results of the regional cartel simulation the analysis focuses, simultaneous to the quota cartel, on “cartel phase II”, while “formation” and “cartel phase I” can be seen as equal to the already described price cartel. The only to mention difference is that, due to the independence of each suppler in his alleged region price changes occur without delays, since the cartel member can assert price changes by himself. This can be seen through the more volatile behaviour of the price changes compared to the price and quota cartel. (Figure 8)

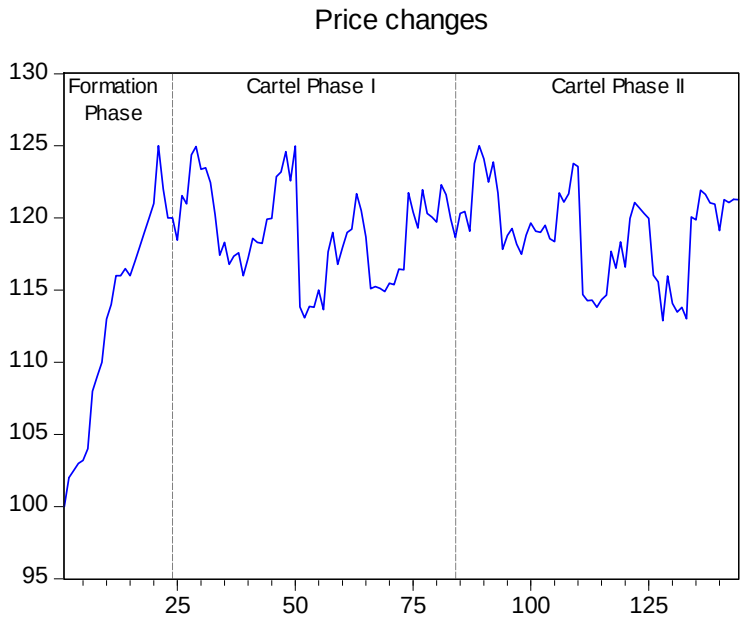

Figure 8, Price changes, Regional cartel

3.4.1 Simulation of capacity growth rate changes

The initial point for the quota cartel simulation analysis is the capacity growth rate.
It was assumed above that a cartel member who feels unthreaded in his market power is downsizing his existing capacities.

Therefore the assumption for the capacity growth rate change marker was:

- Decreasing capacity growth rate changes during “Cartel phase II”

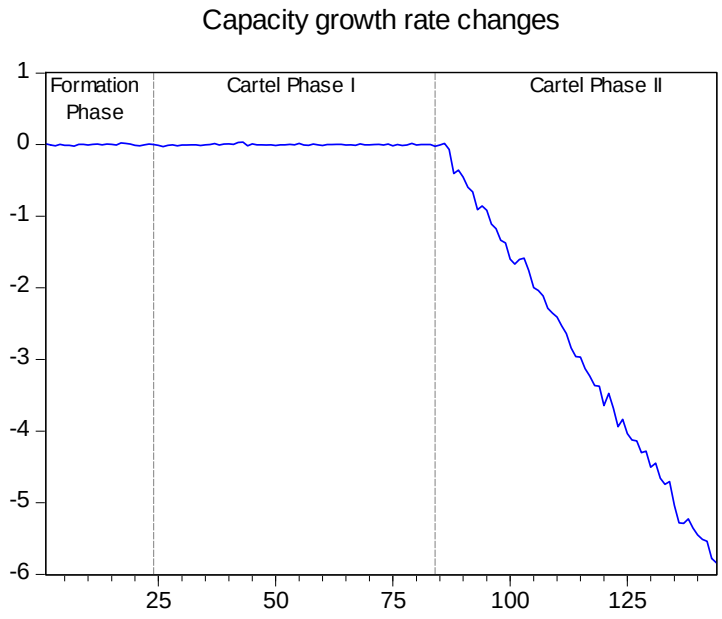

Figure 9, Capacity growth rate changes, Regional cartel

Figure 9 proves clearly the in the description made assumption, that at a certain point regional cartels begin to downsize their capacities. One can observe this through a continuous decrease of the capacity growth rate change throughout “cartel phase II”.

3.4.2 Simulation of capacity utilization rate changes

As already described in the simulation of the quota cartel, changes of the capacity growth rate have a direct influence on the capacity utilisation rate.

For the capacity utilisation rate marker was assumed:

- An increase of the capacity utilisation rate in “Phase II”

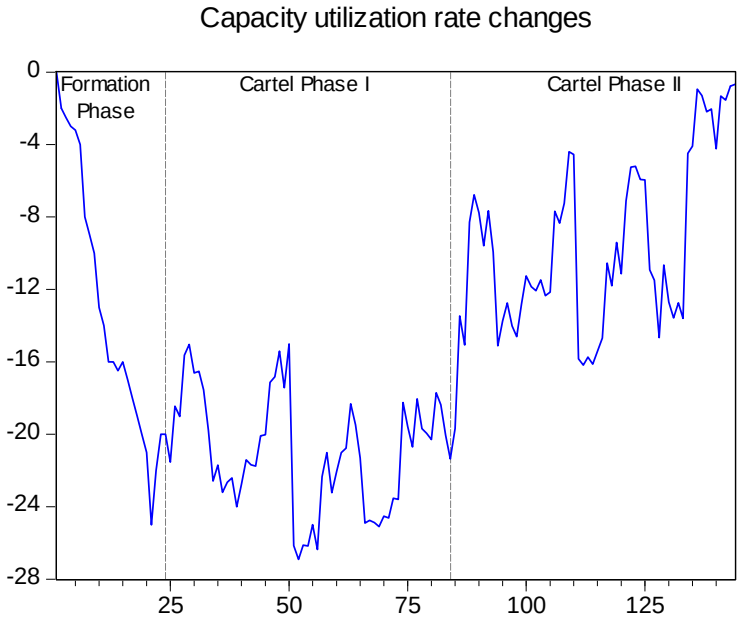

Figure 10, Capacity utilization rate changes, Regional cartel

By looking at figure 10 the assumed influence becomes clearly proven. As a cause of the capacity downsizing of the cartel, one can observe a sudden increase of the capacity utilisation rate at the beginning of “cartel phase II”. After that, the utilization rate continues on a certainly higher level throughout “cartel phase II”, compared to “cartel phase I”.

3.4.3 Simulation of Rate of return difference

The rate of return difference marker displays the actual reason for the downsizing of capacities.

For the rate of return difference marker was assumed above:

- Further increase in “cartel phase II” compared to “phase I”

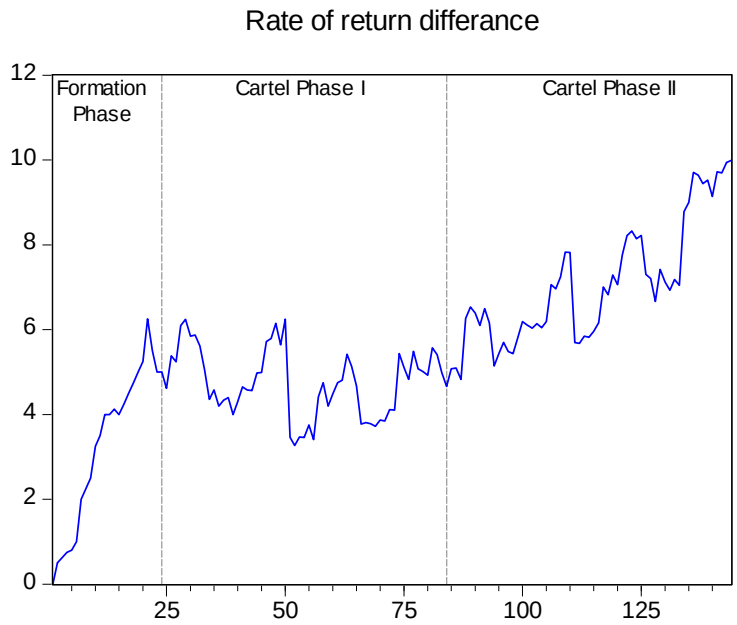

Figure 11, Rate of return difference, Regional cartel

The assumed increase of the rate of return difference during “cartel phase II” becomes verified through figure 11. One observes a steady increase of the rate of return difference as a result of downsizing capacities by the regional cartel. The increase will come to an end once the new maximum rate of return difference, based on existing capacities, is reached.
As one can conclude now, the regional cartel uses the downsizing of capacities for increasing rates of return

3.5 Simulation of a competitive benchmark

3.5.1 Simulation of price changes

The results for the simulation of a competitive market have to be seen as a benchmark for the different cartel types. The behaviour of each marker displays how the marked is originally supposed to work in terms of each marker.

For the price change marker, many **price changes** with a high distribution where expected.

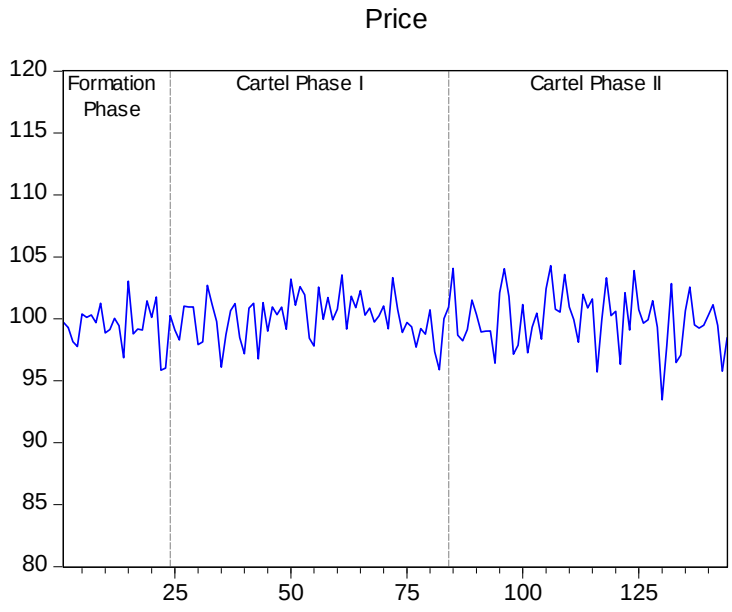

Figure 12 Price, Competition

Figure 12 displays the above assumed price changes with a high distibution. As one can see the price changes stay on the same level throughout the whole observation unlike in a cartel where it raises to a higer level during formation phase and and continues on that new level during “cartel phase I and II”

3.5.2 Simulation of the capacity growth rate

The capacity utilization rate was expected to react quickly to demand changes with a high utilization distribution.

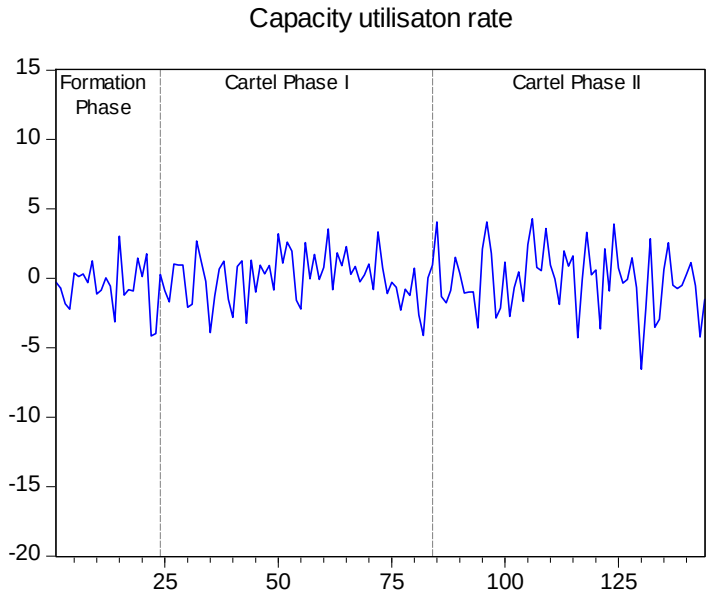

Figure 13, Capacity growth rate, Competition

Observing figure 13 the above assumed distribution of the capacity utilisation rate becomes verified through the behaviour of the marker throughout all three phases. As a comparison the capacity utilisation rate of all three described cartel types, decreases during formation phase and strives to a different then the zero utilization level depending on which cartel type is being compared.

3.5.3 Simulation of the capacity growth rate change

For the capacity growth rate**,** changes around zero level where expected.

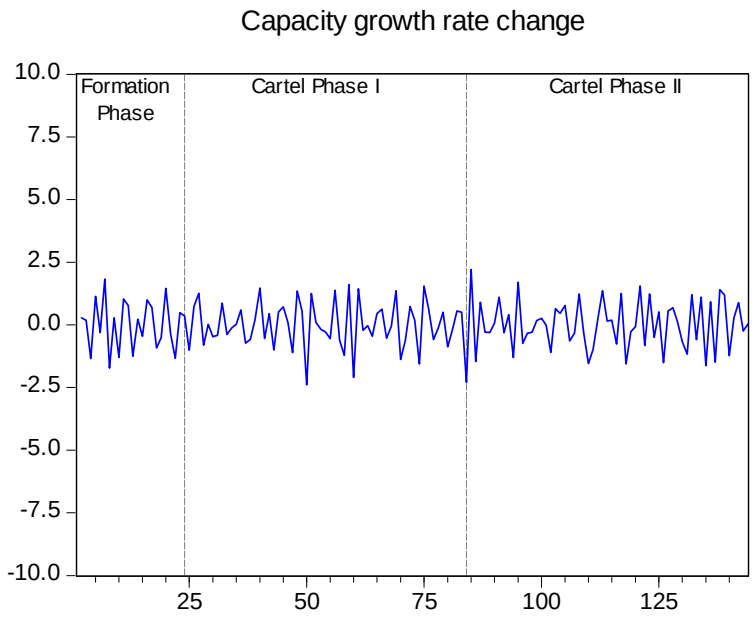

Figure 14, Capacity growth rate change, Competition

The simulation of the capacity growth rate verifies the assumed behaviour in figure 14 Throughout the observation, changes on a zero level can be observed for a competitive market. As a comparison one could observe continuously decreasing capacity growth rate changes for the quota cartel and continuously increasing capacity growth rates for the regional cartel.

3.5.4 Simulation of the rate of return difference

The rate of return difference was expected to fluctuate on a zero level during the whole observation.

Figure 15, Rate of return differnace, Competition

For the last marker simulation also verifies the assumed behavior in figure 15. The changes for the competitive benchmark occur on a zero level, while for the price cartel increasing, the quota cartel decreasing and for the regional cartel again increasing rates of return could be observed.

4. Empirical Analysis „cartels vs. competition“

4.1 Testing methods

In section 3 was found proof for the assumed behaviour of each cartel type by analyzing the behaviour of the simulation outputs. Section 4 is now going to extend the visual proof to an empirical proof by testing the simulation results for their significance and correlation. *Blanckenburg and Geist* (2009) developed indicators for such a testing method in their System of Cartel Markers (SCM).

In the following, indicators, testing methods and expected results will be briefly introduced.

a) Utilization of capacities

For the utilisation rate of capacities the Augmented Dickey-Fuller-Test (ADF-Test) will be used. It tests stationary of a variable for a determined time horizon, with Ho: “Variable has a unit root“. Variables have been tested for zero stationary and/or. intercept stationary.

In order to analyze the behaviour of each marker in case of denying Ho, a trend test has been made to examine in which direction the utilization rate is going to develop.

Table 4: Test results Utilisation of capacities

Phase	**Expected behaviour**
Cartel formation	Negative trend
Cartel	Negative trend or intercept stationary
Competitive	Stationarity

b) Correlation between utilization rate of capacities and price changes

The test is supposed to point out the influence of changes in the capacity utilization rate on price changes. It is assumed that exogenous shocks cause first capacity utilization adjustments, which then again cause price changes. For the test the following regression equation is assumed:

$$dp = a \pm \beta x d$$

Table 5: Test results Correlation rate of capacities and price changes

Phase	Expected behaviour
Cartel formation	Independency or negative correlation
Cartel	Positive correlation (but lower adjustment speed)
Competitive	Positive correlation

c) Rate of return difference

As already seen for the utilization of capacities, the rate of return difference will also be tested with the ADF-Test pattern, for intercept stationary, zero stationary and a trend.

Table 6: Test results Rate of return difference

Phase	Expected behaviour
Cartel formation	Positive trend
Cartel	Not zero stationary
Competitive	Stationarity

d) Correlation between rate of return difference and capacity growth rate changes.

Analog to the testing idea in b) the correlation of rate of return difference and capacity growth rate changes is supposed to show whether the rate of return difference has a significant influence on the capacity growth rate or not. This follows the assumption, that high rates of return on a competitive market attract newcomers, which leads in total to an increasing capacity growth rate of the market. If not, the observed market can be seen as a cartel market.

Table 7: Test results Correlation of return difference and capacity growth rate changes

Phase	Expected behaviour
Cartel formation	No correlation
Cartel	No positive correlation (negative correlation in Type II and III , no correlation in Type I)
Competitive	Positive correlation

e) Distribution of nominal price changes

The price change density is expected to be significantly higher for a cartel market than for a competitive benchmark. V. Blanckenburg and Geist used the Kolmogorov-Smirnov test to examine the behavior of the price changes density. For a deeper analysis see: *" The influence of collusion on price changes: New evidence from major cartel cases."*

f) Variance of capacity growth rate changes

The variance of capacity growth rate changes is tested by a test of variance equality for the capacity growth rate changes of a cartel and a competitive benchmark. It is assumed that the variance for capacity growth rate changes is significantly lower for cartels than for a competitive benchmark because in general cartels are less likely to downsize or expand their capacity rather then adjusting their capacity utilization level.

Table 8: Test results Variance of capacity growth rate changes

Phase	**Expected behaviour**
Cartel formation	Variance competition > Variance cartel
Cartel	Variance competition > Variance cartel
Competitive	--

4.2 Empirical results

4.2.1 Type I: Price cartel

Table 9: Test results on applied Price cartel simulation data

	Formation Phase Sample 1-24	Cartel Phase Sample 25-84
a) Utilization rate of capacities	Xd is not zero stationary (p = 0.8672) Xd is not intercept stationary (p= 0.2721) Xd has a negative trend $Xd = -1.04 * t$ $(p < 0.01\ ;\ R^2 = 0.89)$	Xd is not zero stationary (p = 0.5219) Xd is intercept stationary (p = 0.0910) Xd does not have a negative trend $Xd = -0.0244 * t$ $(p = 0.2828\ ;\ R^2 = 0.02)$
b) Correlation between utilization rate of capacities and price changes	Δp and Xd are independent $\Delta p = 0.9 + 0.002Xd$ $(p = 0.36)\ ;\ (p = 0.97)$	Δp and Xd are positive correlated $\Delta p = 3.81 + 0.181Xd$ $(p = 0.03); (p = 0.028)$
c) Rate of return difference	Rd is not zero stationary $(p = 0.8762)$ Rd is not intercept stationary (p = 0.6037) Rd has a positive trend $Rd = 0.26 * t$ $(p < 0.01\ ;\ R^2 = 0.905)$	Rd is not zero stationary (p = 0.5265) Rd is intercept stationary (p = 0.0107) Rd does not have a trend $Rd = 5.05 - 0.006 * t$ $(p = 0.00)\ ; (p = 0.2626)$
d) Correlation between rate of return difference and capacity growth rate changes	Rd has no influence on dW $(p = 0.9469)$	Rd has no influence on dW (p = 0.7577)
e) Distribution of price changes	See von Blanckenburg and Geist	
f) Variance of capacity growth rate changes	Higher variance for competitive benchmark Std.Dev.comp = 0.9968 vs. Std.Dev.cart = 0.0108	Higher variance for competitive benchmark Std.Dev.comp = 0.9473 vs. Std.Dev.cart = 0.019

Table 9 shows the empirical results for the first cartel type, the price cartel. As already seen in the simulation of the cartel types, the observation sample has been subdivided into formation and cartel phase. Each phase has been tested separately for each indicator a) - f).

a) Utilization rate of capacities

One finds clear evidence for the assumed negative trend of the capacity utilisation rate during “formation phase”, which underlines the cartels behaviour of under utilizing capacities during its formation. This creates a situation of excess demand which makes it easier to assert the increased cartel prices. The during cartel phase assumed intercept stationarity of the utilization rate becomes also proven in table 9 This goes back to the achievement of the new targeted capacity utilisation level which is certainly lower compared to a competitive benchmark

b) Correlation between utilization rate of capacities and price changes

During “formation phase” the assumed independency of price changes and capacity utilisation rate is verified by the results of table 9 The independency of the two markers states the typical cartel behaviour of increasing prices and reducing quantities, during formation face, independently from any exogenous shocks. One also observes the assumed positive correlation during “cartel phase” by a positive and significant Xd. The positive correlation points out the cartels reaction to demand changes with delayed price changes.

c) Rate of return difference

The results for the rate of return difference in table 9 state a positive trend of the rate of return difference during “formation phase”. The result fits the expected behaviour of increasing rates of return during cartel formation. For the “cartel phase” intercept stationarity can be observed which underlines the assumption of continuously higher rate of return level compared to a competitive bench mark, where one would observe zero stationarity. Table I: appendix

d) Correlation between rate of return difference and capacity growth rate

While throughout a competitive market a positive correlation of can be found, since higher rates of return attract new companies to the market, table 9 proofs a different behaviour for “formation” and “cartel phase” of a cartel market. Here one finds in both

phases no correlation between rate of return difference and capacity growth rate. One reason for that would be that the market contains entry barriers which scare new comers to enter the market. Another reason can be found in the alleged price cartel behaviour. It was assumed that the cartel operates with fixed capacities; therefore there cannot be any correlation between the both markers. However one should expect that the higher rates of return are due to the monopolistic pricing behaviour of the cartel.

e) Distribution of price changes

Not processed, see above.

f) Variance of capacity growth rate changes

Table 9 also proves the above made assumption for the variances of a cartel, compared to a competitive benchmark. One finds for "formation" and "cartel phase" a certainly higher variance for the competitive benchmark. Such a low variance indicates a cartel market with fixed capacities. Therefore it can be assumed that cartels only react to demand shocks with utilization adjustments but not with capacity extensions or downsizing.

4.2.2 Type 2: Quota cartel

Table 10 Test results on applied Quota cartel simulation data

	Formation Phase Sample 1-24	Cartel Phase I Sample 25-84	Cartel Phase II Sample 85-144
a) Utilization rate of capacities	Xd is not zero stationary (p = 0.8672) Xd is not intercept stationary (p = 0.2721) Xd has a negative trend $Xd = -1.04 * t$ $(p < 0.01\ ;\ R^2 = 0.89)$	Xd is not zero stationary (p = 0.5219) Xd is intercept stationary (p = 0.0910) Xd does not have a negative trend $Xd = -0.0244 * t$ $(p = 0.2828\ ;\ R^2 = 0.02)$	Xd is not zero stationary (p=0.8216) Xd is not intercept stationary (p=0.3882) Xd has a negative trend $Xd = -1.28 - 0.2263 * t$ $(p = 0.626\ ;\ p = 0.000)$
b) Correlation between utilization rate of capacities and price changes	Δp and Xd are independent $\Delta p = 0.9 + 0.002Xd$ $(p = 0.36)\ ;\ (p = 0.07)$	Δp and Xd are positive correlated $\Delta p = 3.81 + 0.181Xd$ $(p = 0.03); (p = 0.028)$	Δp and Xd are independent $\Delta p = 1.89 + 0.07 * Xd$ $(p = 0.1742\ ; p = 0.1672)$
c) Rate of return difference	Rd is not zero stationary $(p = 0.8762)$ Rd is not intercept stationary (p = 0.6037) Rd has a positive trend $Rd = 0.26 * t$ $(p < 0.01\ ;\ R^2 = 0.905)$	Rd is not zero stationary (p = 0.5265) Rd is intercept stationary (p = 0.0107) Rd does not have a trend $Rd = 5.05 - 0.006 * t$ $(p = 0.00)\ ; (p = 0.2626)$	Rd has a unit root (p= 0.0839) Rd is not intercept stationary (p=0.6453) Rd has a negative trend $Rd = 12.153 - 0.086 * t$ $(p = 0.000\ ;\ p = 0.000)$
d) Correlation between rate of return difference and capacity growth rate changes	Rd has no influence on dW $(p = 0.9469)$	Rd has no influence on dW (p = 0.7577)	Rd has a negative influence on dW $dW = 10.25 - 1.833 * t$ (p=0.000 ; p=0.000)
e) Distribution of price changes	See von Blanckenburg and Geist		
f) Variance of capacity growth rate changes	Higher variance for competitive benchmark Std.Dev.comp = 0.9968 vs. Std.Dev.cart = 0.0108	Higher variance for competitive benchmark Std.Dev.comp = 0.9473 vs. Std.Dev.cart = 0.019	Higer variance for the cartel Std.Dev.comp = 2.4127 vs. Std.Dev.cart = 3.4519

As also proceeded during the quota cartel simulation analysis, the description of its empirical results focus on the added "cartel phase II" and neglect the results for "formation" and "cartel phase I", since they are equal to the before analyzed price cartel. Further one should have in mind, that among other things the quota cartel was characterized through increasing capacity growth rates during "cartel phase II" in order to obtain higher cartel revenues.

a) Utilization rate of capacities

Looking at table 10 one will find a highly significant negative trend of the capacity utilisation rate during "cartel phase II" which is typical for the quota cartel. It can be explained through the increasing capacity growth rate during "phase II" which consequently leads to further decrease of the already underutilized capacity utilization.

b) Correlation between utilization rate of capacities and price changes.

Table 10 states independence for utilization rate and price changes, while a positive correlation was expected. The deviation from the expected behaviour can be explained through the interdependency of capacity utilisation, capacity growth and price changes. The increase of capacities draws harder on the capacity utilisation, then exiguous demand shocks. This can be seen as a bias of the assumed testing results for the correlation between utilization rate of capacities and price changes.

c) Rate of return difference

By looking at the of return difference indicator throughout "cartel phase II" one can observe a highly significant negative trend in table 10 The increasing capacities cause additional costs leading to a significant reduction of the rate of return difference which can be concluded through the negative trend.

d) Correlation between rate of return difference and capacity growth rate

What has been already mentioned in c) and assumed above becomes now proven through the correlation indicator of rate of return difference and capacity growth rate. Table 10 displays a negative influence from the rate of return difference on capacity growth rate, which makes sense once one thinks of the behaviour of both markers in the simulation analysis. The rate of return has to have a negative impact on capacity

growth in order to create increasing capacity growth rates while the rate of return difference decreases.

This becomes obvious once one inverts the created regression equation to Rd.

$$Rd = 5.59 - 0.545dW$$

The equation shows clearly the negative impact of the capacity growth rate on the rate of return difference.

d) Distribution of price changes

Not processed, see above.

e) Variance of capacity growth rate changes

In opposite to the expected behaviour one can observe a higher variance for the cartel compared to the competitive bench mark. This can simply be explained through the typical increase of the capacities during “phase II” in a quota cartel, while on a competitive marked changes on a zero level can be observed.

4.2.3 Type 3: Regional cartel

Table 11: Test results on applied Regional cartel simulation data

	Formation Phase Sample 1-24	Cartel Phase I Sample 25-84	Cartel Phase II Sample 85-144
a) Utilization rate of capacities	Xd is not zero stationary (p = 0.9493) Xd is not intercept stationary (p = 0.3911) Xd has a negative trend $Xd = -1.0134 * t$ $(p < 0.01\ ;\ R^2 = 0.923$	Xd is not zero stationary (p = 0.5611) Xd is intercept stationary (p = 0.0447) Xd does not have a negative trend $Xd = -0.0338 * t$ $(p = 0.1517\ ;\ R^2 = 0.03)$	Xd has a unit root = (zero stationary) (p= 0.0465) Xd is intercept stationary (p= 0.0905) Xd has a positive trend $Xd = -26.94 + 0.153 * t$ $(p < 0.00\ ;\ R^2 = 0.30)$
b) Correlation between utilization rate of capacities and price changes	Δp and Xd are independent $\Delta p = 1.346 + 0.03477 Xd$ $(p = 0.0813)\ ;\ (p = 0.4758)$	Δp and Xd are positive correlated $\Delta p = 5.455 + 0.2603 Xd$ $(p = 0.0053); (p = 0.0047)$	Δp and Xd are positive correlated $\Delta p = 1.3478 + 0.1361 Xd$ $(p = 0.0310); (p = 0.0199)$
c) Rate of return difference	Rd is not zero stationary $(p = 0.9493)$ Rd is not intercept stationary (p = 0.3911) Rd has a positive trend $Rd = 0.25 * t$ $(p < 0.01\ ;\ R^2 = 0.922)$	Rd is not zero stationary (p = 0.4835) Rd is intercept stationary (p = 0.0447) Rd does not have a trend $Rd = -0.008 * t$ $(p = 0.1517)\ ;(R^2 = 0.03511)$	Rd is not zero stationary (p= 0.9137) Rd is not intercept stationary (p= 0.6558) Rd has a positive trend $Rd = 0.0689 * t$ $(p < 0.01\ ;\ R^2 = 0.711)$
d) Correlation between rate of return difference and capacity growth rate changes	Rd has no influence on dW $(p = 0.7659)$	Rd has a negative influence on dW $dW = -0.0059\ Rd$ (p = 0.096 ; $R^2 = 0.047$)	Rd has a negative influence on dW $dW = -2.0651\ Rd$ p = 0.000 ; $R^2 = 0.713$)
e) Distribution of price changes	See von Blanckenburg and Geist		
f) Variance of capacity growth rate changes	Higher variance for competitive benchmark Std.Dev.comp = 0.9968 vs. Std.Dev.cart = 0.0129	Higher variance for competitive benchmark Std.Dev.comp = 0.947 vs. Std.Dev.cart = 0.021	Higher variance for the cartel Std.Dev.cart = 3.4917 vs. Std.Dev.comp = 0.9554

The empirical results for the regional cartel can be found in table 11the main focus for the analysis lies again on “cartel phase II” since it shows the speciality of the regional cartel. Here one should have in mind, that price changes occur more often and less delayed, and that the cartel will begin to downsize its capacities at a point where it feels unthreaded.

a) Utilization rate of capacities

By looking at the results for “cartel phase II” on will notice that two of the expected results do not fit to the expected behaviour. One finds zero and intercept stationarity instead of denying both. This can be seen as weakness of the unit root test once it comes to more volatile data with a trend. However, what can be found is a positive trend just as it was expected during “phase II”

b) Correlation between utilisation rate of capacities and price changes

As indicated for a cartel, one can observe a significant positive correlation between capacity utilization and price changes during “phase II” in table 11.

c) Rate of return difference

Table 11 displays a highly significant positive trend for the rate of return difference in “cartel phase II”. This proves the expected behaviour and is a first evidence for the positive impact downsizing of capacities has on the rate of return difference.

d) Correlation between rate of return difference and capacity growth rate change

One can find the expected behaviour with a highly significant negative correlation between both markers in table 11. The result follows the already in c) mentioned connection between rate of return difference and capacity growth rate. It reflects the cartels goal of achieving higher rates of return through downsized capacities and so decreased capacity costs. Such a connection would only be observed on a cartel market, since on a competitive market increasing rates of return would generally attract new comers to the marked which would lead to increasing capacity growth rates and a positive correlation testing result. (See table I appendix.)

e) Distribution of price changes

Not processed, see above.

f) Variance of capacity growth rate changes

Also for the regional cartel in "cartel phase II" one can observe a higher variance of capacity growth rate changes for the cartel market than for the competitive benchmark. The explanation for such behaviour can be seen as equal to the quota cartel just with the for the regional cartel typical decrease of capacities as reason for the higher variance.

5. Conclusion

In this work the appearance of disequilibria has been used to model empirical correlation between market process variables such as, price, capacity and rate of return in order to find evidence for cartel behaviour. Therefore in a first step different cartel types were theoretically distinguished and in a second, their behaviour in terms of market process variables simulated. Those variables were defined by the System of Cartel Markers and represented, together with the theoretical description of each cartel type, the foundation for the cartel type simulation. The simulation consisted out of fictional data deducted from previously observed cartel data samples. In the simulation analysis was found proof for the theoretical alleged behaviour of the different cartel types. The specialities of each cartel could be discovered during the different cartel phases. To picture the undesired development, a comparison to a competitive benchmark was introduced.

Finally the SCM testing pattern was applied to the generated data to detect empirical evidence like correlation or trends in the observed market processes which conclude the presence of a cartel or collusive behaviour.

The SCM provided solid empirical proof for the presences of a cartel throughout the examined markers for each cartel type. Almost all of the examined markers showed at least significance for their previously alleged behaviour. Those good results underline, that the SCM can be seen as a quiet qualified tool, to detect collusive behaviour based on empirical data.

This work can be used as a guideline for cartel simulations and as support for the detection of certain cartel types. Simulated or empirical cartels can be analysed with the methods of the

SCM. The introduced simulation can also be applied for other cartel types which have not been introduced in this work.

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7. Appendix

7.1 Table I. Simulation Results Competitive bench mark

	Competition		
	Formation Phase Sample 1-24	Cartel Phase I Sample 25-84	Cartel Phase II Sample 85-144
a) Utilization rate of capacities	Xd is zero stationary (p = 0.0001) Xd is intercept stationary (p = 0..0005) Xd does not have a trend $(p = 0.734)$	Xd is zero stationary (p = 0.0000) Xd is intercept stationary (p = 0.0000) Xd does not have trend $(p = 0.9905)$	Xd is zero stationary (p= 0.000) Xd is intercept stationary (p= 0.000) Xd has a positive trend $(p = 0.3301)$
b) Correlation between utilization rate of capacities and price changes	Xd has a no influence on Δp $(p = 0.000)$	Xd has a no influence on Δp $(p = 0.000)$	Xd has a no influence on Δp $(p = 0.000)$
c) Rate of return difference	Rd is zero stationary (p = 0.0000) Rd is intercept stationary (p = 0.0004) Rd does not have a trend $(p = 0.8651)$	Rd is zero stationary (p = 0.0000) Rd is intercept stationary (p = 0.0000) Rd does not have a trend $(p = 0.9340)$	Rd is zero stationary (p = 0.000) Rd is intercept stationary (p = 0.0000) Rd does not have a trend $(p = 0.7278)$
d) Correlation between rate of return difference and capacity growth rate changes	Rd has a positive influence on dW $(p = 0.0000\,;\ R^2 = 0.562)$	Rd has a positive influence on dW $(p = 0.0000\,;\ R^2 = 0.5530)$	Rd has a positive influence on dW $(p = 0.0000\,;\ R^2 = 0.4226)$
e) Distribution of price changes	---	---	---
f) Variance of capacity growth rate changes	Higher variance for competitive benchmark Std.Dev.comp = 0.9968 vs. Std.Dev.cart = 0.0129	Higher variance for competitive benchmark Std.Dev.comp = 0.947 vs. Std.Dev.cart = 0.021	Higer variance for the cartel Std.Dev.cart = 3.4917 vs. Std.Dev.comp = 0.9554

7.2.1 Table II.

Data panel Price Cartel

Observation	P	XD	DW	RD
1	100	0,450626465	0,002157008	-0,009993308
2	100	-0,89146094	0,028126876	0,034352574
3	100	0,34452148	0,003650539	-0,112083664
4	102	-2,98460562	-0,004525683	0,53063801
5	102	-1,475774836	0,011036747	0,338493828
6	102	-1,525780449	0,010080759	0,406841151
7	110	-10,60974776	-0,001038199	2,460087587
8	110	-11,81848005	-0,001878415	2,434272371
9	110	-10,61687967	-0,010681084	2,420330707
10	113	-13,40634808	-0,025052269	3,329231767
11	113	-13,97657623	-0,007761157	3,286065101
12	113	-12,99574671	0,005370114	3,381913268
13	113	-13,61488934	-0,003042216	3,29779879
14	113	-12,79520654	0,020018086	3,260096436
15	118	-17,57481187	-0,025238052	4,464399318
16	118	-19,42862337	-0,012866375	4,438276076
17	118	-18,30401496	-0,019507776	4,439658446
18	118	-18,69820961	0,000675876	4,446447566
19	122	-21,47347612	0,008805435	5,500311284
20	122	-21,41765143	-0,004318976	5,533432744
21	122	-21,52326962	0,034074337	5,569837137
22	120	-20,65738385	-0,011695735	5,067629429
23	120	-20,6563397	0,012427387	5,012506685
24	120	-20,33990859	-0,000352946	4,980671862
25	120	-21,74692714	0,025844823	5,000835141
26	120	-20,42210533	0,005854346	5,091212016
27	120	-19,75301437	0,012255002	4,902812357
28	124	-16,30047799	0,032337326	6,009232232
29	124	-15,56301765	-0,003804486	5,885678126
30	124	-16,07494855	0,014880124	6,15837259
31	123	-17,33237528	0,02004383	5,684868509
32	123	-18,00739034	0,002850723	5,473886416
33	121	-19,28775794	0,003273323	5,275702301
34	117	-22,56730319	0,014489273	4,173118951
35	117	-22,95617336	-0,026609824	4,18112153
36	117	-24,07167175	-0,007642683	4,098022732
37	117	-23,65130944	0,002271251	4,065121671
38	117	-22,52076896	0,023904363	4,242152807
39	117	-23,04797534	0,016303038	4,014893307
40	119	-21,78016483	-0,017692423	4,841471936
41	119	-20,49206864	-0,001665572	4,779078312
42	119	-21,07882147	0,032519405	4,808622723
43	119	-21,61356717	0,022921514	4,877188873
44	119	-19,57908442	-0,005486614	4,775839467
45	119	-21,46689829	0,041511986	4,73698747
46	123	-17,01729116	-0,015431749	5,871778054
47	123	-16,60748109	-0,033436077	5,693604397
48	123	-16,86223812	0,008581893	5,824282991
49	123	-18,8803799	-0,005567419	5,831320584

50	123	-17,62329001	0,005108498	5,650512098
51	114	-25,49569079	0,001026791	3,451236567
52	114	-26,07877742	0,015697108	3,533779338
53	114	-26,6515342	-0,017009942	3,571993895
54	114	-24,91096081	-0,023405491	3,530625984
55	114	-25,41411023	-0,024678224	3,569241276
56	114	-24,29684872	-0,010922483	3,438563548
57	118	-22,73601451	-0,022498387	4,343329653
58	118	-21,95314379	0,027640172	4,619823105
59	118	-21,40929886	-0,033638893	4,507897543
60	118	-23,42128972	-0,015328488	4,473541292
61	120	-20,15302063	-0,023601063	4,859582975
62	120	-19,81214521	-0,02950568	4,779766684
63	120	-17,94563074	0,014066531	4,957180849
64	120	-20,5451895	-0,01639189	5,000727213
65	120	-20,6149276	-0,002195018	4,985497255
66	115	-23,934954	-0,02000956	3,813962888
67	115	-25,39275376	0,009082848	3,758680594
68	115	-24,70022671	0,003368778	3,742583562
69	115	-26,20675138	-0,011385298	3,825750634
70	115	-25,49332534	0,006434675	3,60749026
71	115	-25,5572636	-0,000961326	3,790422787
72	115	-25,46288016	0,007015435	3,867348312
73	115	-24,57850125	0,017289374	3,815649146
74	121	-18,13395267	-0,019899046	5,261771785
75	121	-18,27143454	-0,006368243	5,223206251
76	121	-18,61765336	-0,04113233	5,432617237
77	121	-19,74973038	-0,045474642	5,233239801
78	121	-18,916194	-0,006934025	5,350394125
79	121	-18,27619597	-0,012222814	5,415755379
80	121	-18,59306979	-0,007653002	5,273240777
81	121	-20,00939934	-0,01112259	5,331395108
82	121	-21,32734729	0,017534646	5,281046547
83	121	-19,09499967	0,009227618	5,176958131
84	120	-19,04631613	0,001584784	4,881215873

7.2.2 Table III.

Data panel Quota Cartel

Observation	P	XD	DW	RD
1	100	0,45062647	0,00071782	-0,00999331
2	100	-0,89146094	-0,04018325	0,03435257
3	100	0,34452148	0,0383135	-0,11208366
4	102	-2,98460562	0,03695884	0,53063801
5	102	-1,47577484	0,00329437	0,33849383
6	102	-1,52578045	0,00661782	0,40684115
7	110	-10,6097478	0,00917047	2,46008759
8	110	-11,81848	0,0043021	2,43427237
9	110	-10,6168797	-0,02988697	2,42033071
10	113	-13,4063481	0,01563242	3,32923177
11	113	-13,9765762	0,02038469	3,2860651
12	113	-12,9957467	-0,01588642	3,38191327
13	113	-13,6148893	0,02326053	3,29779879
14	113	-12,7952065	0,03269039	3,26009644
15	118	-17,5748119	0,0064536	4,46439932
16	118	-19,4286234	-0,02852978	4,43827608
17	118	-18,304015	-0,01398659	4,43965845
18	118	-18,6982096	-0,01830388	4,44644757
19	122	-21,4734761	0,02970141	5,50031128
20	122	-21,4176514	-0,01771962	5,53343274
21	122	-21,5232696	-0,00261802	5,56983714
22	120	-20,6573839	-0,02112109	5,06762943
23	120	-20,6563397	0,0269679	5,01250669
24	120	-20,3399086	0,00649575	4,98067186
25	120	-21,7469271	-0,02825293	5,00083514
26	120	-20,4221053	0,01441197	5,09121202
27	120	-19,7530144	-0,00729619	4,90281236
28	124	-16,300478	-0,00043995	6,00923223
29	124	-15,5630177	-0,01585819	5,88567813
30	124	-16,0749486	-0,00390058	6,15837259
31	123	-17,3323753	-0,01721181	5,68486851
32	123	-18,0073903	-0,0017073	5,47388642
33	121	-19,2877579	0,00254208	5,2757023
34	117	-22,5673032	0,00259609	4,17311895
35	117	-22,9561734	0,00254775	4,18112153
36	117	-24,0716718	-0,0261837	4,09802273
37	117	-23,6513094	-0,0092006	4,06512167
38	117	-22,520769	0,01573323	4,24215281
39	117	-23,0479753	0,00241269	4,01489331
40	119	-21,7801648	-0,00683681	4,84147194
41	119	-20,4920686	0,00614607	4,77907831
42	119	-21,0788215	0,01844674	4,80862272
43	119	-21,6135672	-0,00911372	4,87718887
44	119	-19,5790844	0,01158676	4,77583947
45	119	-21,4668983	0,00624919	4,73698747
46	123	-17,0172912	0,01034978	5,87177805
47	123	-16,6074811	0,00771253	5,6936044
48	123	-16,8622381	0,01420951	5,82428299
49	123	-18,8803799	-0,01945756	5,83132058

50	123	-17,62329	-0,00401125	5,6505121
51	114	-25,4956908	-0,00989457	3,45123657
52	114	-26,0787774	-0,00715868	3,53377934
53	114	-26,6515342	0,01082684	3,5719939
54	114	-24,9109608	0,00081884	3,53062598
55	114	-25,4141102	-0,00866576	3,56924128
56	114	-24,2968487	-0,00217773	3,43856355
57	118	-22,7360145	0,02724459	4,34332965
58	118	-21,9531438	0,01697715	4,6198231
59	118	-21,4092989	0,00271601	4,50789754
60	118	-23,4212897	0,00619491	4,47354129
61	120	-20,1530206	0,02222515	4,85958297
62	120	-19,8121452	0,00662173	4,77976668
63	120	-17,9456307	0,02554472	4,95718085
64	120	-20,5451895	0,02323942	5,00072721
65	120	-20,6149276	-0,01484706	4,98549726
66	115	-23,934954	-0,01568495	3,81396289
67	115	-25,3927538	0,00673402	3,75868059
68	115	-24,7002267	0,02647683	3,74258356
69	115	-26,2067514	0,03851273	3,82575063
70	115	-25,4933253	0,03677056	3,60749026
71	115	-25,5572636	-0,02500791	3,79042279
72	115	-25,4628802	0,00757989	3,86734831
73	115	-24,5785013	0,02263971	3,81564915
74	121	-18,1339527	0,00604041	5,26177179
75	121	-18,2714345	-0,02564336	5,22320625
76	121	-18,6176534	0,01333457	5,43261724
77	121	-19,7497304	-0,0188169	5,2332398
78	121	-18,916194	-0,01024908	5,35039412
79	121	-18,276196	0,02313249	5,41575538
80	121	-18,5930698	0,00434133	5,27324078
81	121	-20,0093993	0,0274309	5,33139511
82	121	-21,3273473	0,00034286	5,28104655
83	121	-19,0949997	-0,00272645	5,17695813
84	120	-19,0463161	0,00525836	4,88121587
85	120	-20,1141988	0,11419882	4,95432047
86	120	-20,073488	0,073488	4,9706048
87	120	-20,43922	0,43922	4,824312
88	124	-16,2843947	0,28439472	5,88624211
89	124	-16,9731787	0,97317874	5,61072851
90	124	-16,8862916	0,8862916	5,64548336
91	123	-18,1415954	1,14159541	5,29336183
92	123	-18,4188107	1,41881067	5,18247573
93	121	-20,6871801	1,68718008	4,57512797
94	117	-25,232914	2,23291401	3,35683439
95	117	-25,0108169	2,01081689	3,44567324
96	117	-25,2622101	2,26221007	3,34511597
97	117	-25,486831	2,486831	3,2552676
98	117	-25,7551878	2,7551878	3,14792488
99	117	-25,9845647	2,98456471	3,05617411
100	119	-24,1534821	3,15348205	3,48860718
101	119	-24,4462814	3,44628137	3,37148745
102	119	-24,022663	3,02266297	3,54093481
103	119	-24,5477879	3,54778792	3,33088483
104	119	-25,1506424	4,1506424	3,08974304
105	119	-25,0355432	4,03554318	3,13578273

106	123	-21,1781518	4,17815183	4,07873927
107	123	-21,8304117	4,83041171	3,81783532
108	123	-21,6562272	4,6562272	3,88750912
109	123	-21,8378427	4,83784265	3,81486294
110	123	-21,9804395	4,98043955	3,75782418
111	114	-31,1742883	5,17428832	1,43028467
112	114	-31,3772743	5,37727435	1,34909026
113	114	-31,72662	5,72662003	1,20935199
114	114	-31,8777139	5,87771394	1,14891442
115	114	-31,7228447	5,7228447	1,21086212
116	114	-31,8672343	5,86723427	1,15310629
117	118	-28,6282518	6,62825178	1,84869929
118	118	-28,7792037	6,77920365	1,78831854
119	118	-29,044107	7,04410699	1,68235721
120	118	-29,0449413	7,04494125	1,6820235
121	120	-27,3516107	7,3516107	2,05935572
122	120	-27,3792149	7,37921492	2,04831403
123	120	-27,442722	7,44272199	2,0229112
124	120	-27,8499227	7,84992268	1,86003093
125	120	-28,1239448	8,12394479	1,75042208
126	115	-33,2646224	8,26462235	0,44415106
127	115	-33,0871559	8,08715594	0,51513762
128	115	-33,3321287	8,33212874	0,4171485
129	115	-33,8440653	8,84406534	0,21237386
130	115	-33,8723623	8,87236229	0,20105509
131	115	-34,0806617	9,08066167	0,11773533
132	115	-34,6764254	9,6764254	-0,12057016
133	115	-34,7778179	9,77781785	-0,16112714
134	121	-28,2711689	9,27116887	1,54153245
135	121	-28,5177403	9,5177403	1,44290388
136	121	-29,0604814	10,0604814	1,22580744
137	121	-29,2179133	10,2179133	1,16283468
138	121	-29,4524543	10,4524543	1,06901826
139	121	-29,6680283	10,6680283	0,98278866
140	121	-29,8959591	10,8959591	0,89161638
141	121	-30,0898236	11,0898236	0,81407057
142	121	-30,7858072	11,7858072	0,53567714
143	121	-30,290302	11,290302	0,73387918
144	120	-32,0725195	12,0725195	0,17099221

7.2.3 Table IV.

Data panel Regional Cartel

OBS	P	DW	XD	RD
1	100		0	0
2	102	-0,01682607	-2	0,5
3	102,5	-0,00930684	-2,5	0,625
4	103	0,02009625	-3	0,75
5	103,2	-0,01253862	-3,2	0,8
6	104	-0,00283246	-4	1
7	108	-0,01038944	-8	2
8	109	0,02577056	-9	2,25
9	110	-0,00085503	-10	2,5
10	113	-0,00844539	-13	3,25
11	114	0,00992539	-14	3,5
12	116	0,0019424	-16	4
13	116	-0,01022337	-16	4
14	116,5	0,00973264	-16,5	4,125
15	116	-0,0009332	-16	4
16	117	-0,01053428	-17	4,25
17	118	0,02800533	-18	4,5
18	119	-0,00628335	-19	4,75
19	120	-0,0102015	-20	5
20	121	-0,01734816	-21	5,25
21	125	-0,00469341	-25	6,25
22	122	0,01139554	-22	5,5
23	120	0,01027972	-20	5
24	120	-0,00579054	-20	5
25	118,459326	-0,02092406	-21,5406744	4,6148314
26	121,541002	-0,0501014	-18,4589983	5,38525042
27	120,97794	-0,0152489	-19,0220602	5,24448494
28	124,369654	-0,00325767	-15,6303464	6,0924134
29	124,953926	-0,03498603	-15,0460737	6,23848157
30	123,385012	-0,00846926	-16,6149884	5,84625291
31	123,473099	-0,01059164	-16,526901	5,86827475
32	122,449878	-0,00507106	-17,5501218	5,61246954
33	120,220953	-0,00609581	-19,7790472	5,0552382
34	117,422795	-0,02337778	-22,5772054	4,35569865
35	118,304122	-0,00454592	-21,6958783	4,57603043
36	116,786215	0,00164466	-23,2137846	4,19655385
37	117,352061	0,02755781	-22,6479388	4,33801529
38	117,584861	-0,01078441	-22,4151391	4,39621522
39	115,99645	0,01665995	-24,0035501	3,99911247
40	117,219173	0,02246241	-22,7808266	4,30479336
41	118,589896	0,01237914	-21,4101044	4,64747389
42	118,31506	0,06113758	-21,6849401	4,57876498
43	118,241007	0,06828408	-21,7589926	4,56025184
44	119,911417	-0,0315848	-20,0885831	4,97785421
45	119,964714	0,02488329	-20,0352862	4,99117845
46	122,865027	-0,0061469	-17,1349729	5,71625678
47	123,18301	-0,00565627	-16,8169902	5,79575245
48	124,594928	-0,00909314	-15,4050722	6,14873195
49	122,568501	-0,00627407	-17,4314995	5,64212513

50	124,992526	-0,02577856	-15,0074737	6,24813158
51	113,841782	-0,00659045	-26,158218	3,46044549
52	113,085405	-0,00508252	-26,9145945	3,27135137
53	113,869837	0,00794121	-26,1301634	3,46745916
54	113,823004	-0,00331258	-26,1769962	3,45575094
55	115,004573	0,03482281	-24,9954271	3,75114323
56	113,64321	-0,01457214	-26,3567901	3,41080247
57	117,657958	-0,0202781	-22,3420421	4,41448949
58	118,988553	0,01327016	-21,0114469	4,74713826
59	116,777849	-0,00135514	-23,2221507	4,19446234
60	117,94609	-0,02560066	-22,0539101	4,48652249
61	118,987542	0,00043969	-21,0124577	4,74688557
62	119,227018	-0,00023083	-20,7729824	4,80675441
63	121,677929	0,0102655	-18,3220711	5,41948221
64	120,515946	0,00822058	-19,4840543	5,12898642
65	118,690479	-0,01144008	-21,3095211	4,67261973
66	115,096366	-0,00197283	-24,9036344	3,77409139
67	115,245588	-0,01592631	-24,7544119	3,81139703
68	115,124348	0,0232382	-24,8756518	3,78108705
69	114,89289	-0,00407425	-25,1071103	3,72322243
70	115,477989	-0,00735614	-24,5220108	3,86949729
71	115,377131	-0,00075371	-24,6228694	3,84428265
72	116,460829	0,01133061	-23,5391711	4,11520724
73	116,411954	-0,01236393	-23,5880457	4,10298857
74	121,752642	0,01505783	-18,2473577	5,43816058
75	120,423282	-0,03147075	-19,5767183	5,10582043
76	119,303251	0,0007691	-20,696749	4,82581275
77	121,961378	-0,02323088	-18,0386222	5,49034444
78	120,313619	-0,01287671	-19,6863809	5,07840477
79	120,046854	0,03727381	-19,9531455	5,01171362
80	119,705764	-0,00904039	-20,2942363	4,92644092
81	122,292443	0,00153886	-17,7075574	5,57311065
82	121,621456	0,00164858	-18,3785441	5,40536399
83	119,940067	0,00073591	-20,0599326	4,98501684
84	118,642992	-0,0486076	-21,3570085	4,66074788
85	120,315763	-0,00923503	-19,6842375	5,07894063
86	120,444357	0,03762549	-13,4599614	5,09603905
87	119,078528	-0,13429963	-15,0636134	4,82335196
88	123,774143	-0,80941573	-8,28419839	6,26730204
89	125,008168	-0,70768782	-6,78169321	6,53511724
90	124,101835	-0,90469916	-7,7629155	6,38733838
91	122,483652	-1,19072391	-9,58052821	6,09720262
92	123,867158	-1,31932702	-7,65336804	6,49452022
93	121,733573	-1,81289204	-9,93346292	6,15855009
94	117,827601	-1,71279327	-15,1113251	5,14201761
95	118,786927	-1,83235214	-13,7446431	5,42967253
96	119,258815	-2,21611958	-12,7474212	5,70115153
97	118,185757	-2,34596281	-14,012553	5,4848244
98	117,484224	-2,66844364	-14,6020651	5,43843347
99	118,811093	-2,74345331	-12,8021254	5,80015465
100	119,64586	-3,19756756	-11,2628139	6,19049213
101	119,087007	-3,3350277	-11,8518639	6,1057627
102	119,016443	-3,20800837	-12,070616	6,03731406
103	119,495184	-3,17355854	-11,4827023	6,14321941
104	118,569707	-3,51637266	-12,3430078	6,04897591
105	118,351841	-3,99424396	-12,1483631	6,18565776

106	121,72832	-4,07196795	-7,68121647	7,0608671
107	121,102088	-4,22600506	-8,34128102	6,96592393
108	121,687264	-4,56572675	-7,24083001	7,24810671
109	123,777604	-4,70309622	-4,38601838	7,82563953
110	123,571721	-4,81832115	-4,53844182	7,82025866
111	114,692784	-5,0587242	-15,8406567	5,69668567
112	114,266632	-5,27496333	-16,1784144	5,67664346
113	114,297675	-5,67555625	-15,737466	5,84464129
114	113,818911	-5,91523561	-16,1201797	5,82082207
115	114,33855	-5,93524785	-15,4246367	5,95873673
116	114,664652	-6,25290364	-14,6830482	6,16732456
117	117,689992	-6,46115656	-10,541854	7,00696059
118	116,521597	-6,72534113	-11,7965828	6,82053569
119	118,338411	-6,74861364	-9,41145267	7,28404809
120	116,599836	-7,2892216	-11,1309915	7,06564767
121	119,963471	-6,94282245	-7,10466556	7,76799667
122	121,070897	-7,36190593	-5,24592842	8,21248654
123	120,707173	-7,87738469	-5,20329018	8,32774717
124	120,30658	-7,67090988	-5,93053658	8,14500886
125	119,97504	-8,07129159	-5,96115701	8,22227652
126	116,024548	-8,25059099	-10,9174961	7,30637349
127	115,568834	-8,2739052	-11,4866101	7,20177068
128	112,879	-8,605758	-14,6515414	6,66205331
129	115,984264	-8,56555553	-10,654901	7,42228826
130	114,072309	-9,0107502	-12,6952487	7,12237722
131	113,479436	-8,89628777	-13,5804457	6,92837406
132	113,804954	-9,31758564	-12,7359743	7,17827273
133	113,005726	-9,48711936	-13,605437	7,0462792
134	120,073838	-9,41595417	-4,48805646	8,78484116
135	119,872589	-10,0763207	-4,08931406	8,99867544
136	121,924119	-10,5630167	-0,93562809	9,70623653
137	121,63805	-10,5770779	-1,2934567	9,64034373
138	121,045031	-10,452664	-2,18879525	9,44232343
139	120,968252	-10,7113496	-2,02992321	9,52660276
140	119,131428	-10,8974197	-4,23172387	9,14182489
141	121,269058	-11,0230625	-1,32716161	9,7264896
142	121,064906	-11,0752456	-1,54037646	9,69632476
143	121,282412	-11,5556699	-0,77719492	9,94287089
144	121,264802	-11,6914565	-0,66430108	9,99278306

7.2.4 Table V.
Data panel Competetive benchmark

OBS	P	RD	DW	XD
1	99,7090699	-0,29662295	-0,23729836	-0,29093012
2	99,2967765	0,06098265	0,04878612	-0,70322352
3	98,1685045	0,29656153	0,23724922	-1,83149552
4	97,777261	-1,37434505	-1,09947604	-2,22273903
5	100,382873	0,04464351	0,03571481	0,38287334
6	100,126016	-0,32970266	-0,26376213	0,1260155
7	100,315456	1,96347149	1,57077719	0,31545575
8	99,6904137	-0,19101724	-0,15281379	-0,30958634
9	101,252452	0,15999514	0,12799611	1,2524523
10	98,8642171	-1,45712891	-1,16570313	-1,13578287
11	99,1376354	-0,15869339	-0,12695471	-0,86236459
12	100,043127	0,80240563	0,64192451	0,04312677
13	99,4430241	-0,75891789	-0,60713432	-0,55697592
14	96,8726665	-0,47880189	-0,38304151	-3,12733348
15	103,027543	-1,03758342	-0,83006674	3,02754331
16	98,7906763	0,21313742	0,17050993	-1,20932369
17	99,1759911	1,08494595	0,86795676	-0,82400892
18	99,0921893	-0,06712423	-0,05369938	-0,90781066
19	101,457533	-0,70551777	-0,56441421	1,45753337
20	100,122868	1,12137423	0,89709939	0,12286775
21	101,761656	0,66821412	0,5345713	1,76165608
22	95,8533077	-0,99711307	-0,79769046	-4,14669228
23	96,0331129	-0,38377298	-0,30701838	-3,96688708
24	100,278097	0,0739968	0,05919744	0,27809658
25	99,1020465	-1,18641265	-0,94913012	-0,89795348
26	98,3020655	-0,26190017	-0,20952014	-1,69793453
27	101,026909	1,31417316	1,05133853	1,02690881
28	100,9553	0,29909106	0,23927285	0,95530002
29	100,961176	0,32499995	0,25999996	0,96117577
30	97,9173422	-0,26215394	-0,20972315	-2,0826578
31	98,1311486	-0,7716878	-0,61735024	-1,86885139
32	102,696975	0,31499862	0,25199889	2,69697464
33	101,202789	-0,15757049	-0,1260564	1,20278901
34	99,7854029	-0,31509362	-0,25207489	-0,21459706
35	96,099769	-0,28382832	-0,22706265	-3,90023101
36	98,7311536	0,46014477	0,36811581	-1,26884643
37	100,673848	-0,4392679	-0,35141432	0,673848
38	101,22715	-1,16510434	-0,93208347	1,22715047
39	98,4997713	-0,9096893	-0,72775144	-1,50022871
40	97,1869468	0,92306483	0,73845186	-2,81305318
41	100,855957	0,24434914	0,19547931	0,85595691
42	101,251506	0,81111736	0,64889389	1,25150591

43	96,7605814	-0,44108274	-0,35286619	-3,23941862
44	101,304176	0,2107027	0,16856216	1,30417572
45	99,0082451	1,1172976	0,89383808	-0,99175489
46	100,951613	1,23012207	0,98409766	0,95161317
47	100,326516	-0,15734985	-0,12587988	0,32651632
48	100,932493	1,53038665	1,22430932	0,93249306
49	99,1534035	2,21133253	1,76906602	-0,84659652
50	103,202358	-0,7697201	-0,61577608	3,20235787
51	101,105623	0,79622668	0,63698134	1,10562342
52	102,604857	0,9212638	0,73701104	2,6048574
53	101,945973	0,70241444	0,56193155	1,9459734
54	98,4265253	0,35260063	0,28208051	-1,57347471
55	97,7991618	-0,33450149	-0,26760119	-2,20083823
56	102,572744	1,39584282	1,11667426	2,57274406
57	99,9695105	0,61398264	0,49118611	-0,03048953
58	101,717495	-0,90902241	-0,72721793	1,71749512
59	99,9195787	1,09775449	0,87820359	-0,08042127
60	100,788681	-1,52282331	-1,21825865	0,78868094
61	103,544363	0,27554413	0,2204353	3,5443627
62	99,1748565	0,0107663	0,00861304	-0,82514351
63	101,827366	-0,02457669	-0,01966135	1,82736633
64	100,905154	-0,59111453	-0,47289162	0,90515383
65	102,279467	-0,02523433	-0,02018746	2,27946698
66	100,298786	0,75864187	0,60691349	0,298786
67	100,860099	0,09229134	0,07383307	0,86009914
68	99,7424697	0,03679605	0,02943684	-0,25753026
69	100,243575	1,73465519	1,38772415	0,24357501
70	101,036802	0,0130759	0,01046072	1,03680185
71	99,1977929	-0,76820244	-0,61456195	-0,8022071
72	103,335193	0,15196021	0,12156817	3,3351933
73	100,75111	0,38125398	0,30500319	0,75111013
74	98,8974371	-1,56497508	-1,25198006	-1,10256289
75	99,7062285	0,37361911	0,29889529	-0,29377153
76	99,3574553	1,16282107	0,93025686	-0,64254467
77	97,7074279	0,44421728	0,35537383	-2,29257213
78	99,2090076	0,25485378	0,20388303	-0,79099244
79	98,7593182	0,89516574	0,71613259	-1,24068184
80	100,725611	-0,19489618	-0,15591694	0,72561127
81	97,3640218	-0,4488311	-0,35906488	-2,63597817
82	95,8866734	0,25128565	0,20102852	-4,11332659
83	100,027778	0,89114269	0,71291415	0,0277776
84	100,940793	-1,96906729	-1,57525383	0,94079322
85	104,062867	0,79059903	0,63247923	4,06286747
86	98,6897988	-1,02878426	-0,82302741	-1,31020115
87	98,2280655	0,09649689	0,07719751	-1,77193449
88	99,1314908	-0,25409519	-0,20327615	-0,86850919
89	101,500548	-0,63729977	-0,50983982	1,50054768

90	100,356293	-0,55587773	-0,44470218	0,35629283
91	98,9348533	0,82246896	0,65797517	-1,06514672
92	99,0051295	0,42917708	0,34334166	-0,99487045
93	99,0162992	0,94221766	0,75377413	-0,98370083
94	96,4204616	-0,68976171	-0,55180937	-3,57953837
95	102,113191	1,44196101	1,15356881	2,11319106
96	104,058829	0,52949838	0,4235987	4,05882857
97	101,803028	0,11515586	0,09212469	1,8030284
98	97,1472223	-0,24943359	-0,19954687	-2,8527777
99	97,8595292	-0,03079236	-0,02463389	-2,1404708
100	101,160902	0,29770849	0,23816679	1,16090209
101	97,2593534	0,28750764	0,23000611	-2,74064656
102	99,3403558	-1,08397853	-0,86718282	-0,65964424
103	100,4579	-0,28064196	-0,22451357	0,45789976
104	98,3463973	0,29299303	0,23439442	-1,65360274
105	102,437395	1,2560245	1,0048196	2,43739492
106	104,285853	0,46216873	0,36973499	4,28585336
107	100,783443	0,04404181	0,03523345	0,78344296
108	100,555191	1,58243556	1,26594845	0,55519118
109	103,589467	1,15998648	0,92798919	3,58946662
110	100,966549	-0,75889291	-0,60711433	0,96654942
111	99,9441741	-1,97989936	-1,58391949	-0,05582587
112	98,1164301	-1,67561288	-1,3404903	-1,88356993
113	101,974703	0,02184275	0,0174742	1,97470328
114	100,875097	0,21360909	0,17088727	0,87509692
115	101,614387	0,44949678	0,35959743	1,61438731
116	95,7207369	-0,50640107	-0,40512085	-4,27926312
117	99,9267076	1,05784113	0,8462729	-0,07329244
118	103,309529	-0,88516944	-0,70813555	3,30952939
119	100,260302	-1,22667862	-0,98134289	0,26030217
120	100,602146	-1,3164868	-1,05318944	0,60214573
121	96,3449044	0,63420807	0,50736646	-3,65509561
122	102,124135	-0,3915502	-0,31324016	2,12413494
123	99,0895848	1,14881118	0,91904894	-0,91041515
124	103,902593	0,52967702	0,42374162	3,90259273
125	100,742711	1,1816057	0,94528456	0,74271085
126	99,6528035	-0,70066558	-0,56053246	-0,34719646
127	99,9219928	-0,00507558	-0,00406047	-0,07800718
128	101,468992	0,85359038	0,68287231	1,46899209
129	99,3400682	0,98667797	0,78934238	-0,65993176
130	93,4597257	0,1586728	0,12693824	-6,54027433
131	97,8299421	-1,3009979	-1,04079832	-2,17005786
132	102,840459	0,20023854	0,16019083	2,84045867
133	96,4671501	-0,53563293	-0,42850634	-3,53284987
134	97,0537939	0,85301219	0,68240975	-2,94620615
135	100,636675	-1,17814505	-0,94251604	0,63667453
136	102,559444	-0,03114518	-0,02491614	2,55944369

137	99,5102371	-1,88783302	-1,51026642	-0,48976286
138	99,257388	-0,12063736	-0,09650989	-0,74261197
139	99,4825243	1,37057585	1,09646068	-0,51747568
140	100,290865	-0,15474869	-0,12379895	0,29086507
141	101,133586	0,19597334	0,15677867	1,13358635
142	99,4714523	1,31500063	1,05200051	-0,52854769
143	95,7816776	1,02605686	0,82084549	-4,21832238
144	98,4715218	1,07294206	0,85835365	-1,52847819

7.3 Outputs empirical Analysis

Table VI. Price Cartel

	Price Cartel	
	Formation Phase Sample 1-24	Cartel Phase Sample 25-84
a) Utilization rate of capacities	**a)** **b)** **c)**	**d)** **e)** **f)**
b) Correlation between utilization rate of capacities and price changes	**g)**	**h)**
c) Rate of return difference	**i)** **j)** **k)**	**l)** **m)** **n)**
d) Correlation between rate of return difference and capacity growth rate changes	**o)**	**p)**
e) Distribution of price changes	See von Blanckenburg and Geist	
f) Variance of capacity growth rate changes	**q)**	**r)**

7.3.1 Type 1: Price Cartel

Formation Phase

a) Utilisation rate of capacities

a) Zero Stationarity

Null Hypothesis: XD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.739052	0.8672
Test critical values:	1% level	-2.669359	
	5% level	-1.956406	
	10% level	-1.608495	

*MacKinnon (1996) one-sided p-values.

b) Intercept Stationarity

Null Hypothesis: XD has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.031697	0.2721
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

c) Trend Test

Dependent Variable: XD
Method: Least Squares
Date: 06/16/10 Time: 15:51
Sample: 1 24
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.785440	1.025910	-0.765604	0.4520
@TREND	-1.040360	0.076431	-13.61169	0.0000

R-squared	0.893862	Mean dependent var	-12.74958
Adjusted R-squared	0.889038	S.D. dependent var	7.780965
E. of regression	2.591915	Akaike info criterion	4.822326
Sum squared resid	147.7965	Schwarz criterion	4.920498
Log likelihood	-55.86792	Hannan-Quinn criter.	4.848371
F-statistic	185.2780	Durbin-Watson stat	0.880537
Prob(F-statistic)	0.000000		

Cartel Phase

d) Zero Stationarity

Null Hypothesis: XD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.434660	0.5219
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

e) Intercept stationarity

Null Hypothesis: XD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.638817	0.0910
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

f) Trend Test

Dependent Variable: XD
Method: Least Squares
Date: 06/28/10 Time: 11:58
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-19.84566	1.266271	-15.67253	0.0000
@TREND	-0.024413	0.022518	-1.084152	0.2828

R-squared	0.019863	Mean dependent var	-21.15177
Adjusted R-squared	0.002964	S.D. dependent var	3.025204
S.E. of regression	3.020717	Akaike info criterion	5.081631
Sum squared resid	529.2345	Schwarz criterion	5.151442
Log likelihood	-150.4489	Hannan-Quinn criter.	5.108938
F-statistic	1.175385	Durbin-Watson stat	0.445244
Prob(F-statistic)	0.282784		

b) Correlation between utilization rate of capacities and price changes

Formation Phase

g)

Dependent Variable: DP
Method: Least Squares
Date: 06/25/10 Time: 16:53
Sample (adjusted): 2 24
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.902038	0.973093	0.926980	0.3645
XD	0.002437	0.064142	0.037997	0.9700

R-squared	0.000069	Mean dependent var	0.869565
Adjusted R-squared	-0.047547	S.D. dependent var	2.180583
S.E. of regression	2.231821	Akaike info criterion	4.526454
Sum squared resid	104.6015	Schwarz criterion	4.625192
Log likelihood	-50.05422	Hannan-Quinn criter.	4.551286
F-statistic	0.001444	Durbin-Watson stat	2.337658
Prob(F-statistic)	0.970049		

Cartel Phase

h)

Dependent Variable: DP
Method: Least Squares
Date: 06/28/10 Time: 12:11
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.818344	1.717457	2.223254	0.0301
XD	0.180521	0.080392	2.245503	0.0286

R-squared	0.079983	Mean dependent var	0.000000
Adjusted R-squared	0.064120	S.D. dependent var	1.931014
S.E. of regression	1.868080	Akaike info criterion	4.120464
Sum squared resid	202.4038	Schwarz criterion	4.190276
Log likelihood	-121.6139	Hannan-Quinn criter.	4.147771
F-statistic	5.042284	Durbin-Watson stat	1.845153
Prob(F-statistic)	0.028562		

c) Rate of return difference

Formation phase

i) Zero Stationarity

Null Hypothesis: RD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.787431	0.8762
Test critical values:	1% level	-2.669359	
	5% level	-1.956406	
	10% level	-1.608495	

*MacKinnon (1996) one-sided p-values.

j) Intercept Stationarity

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.317014	0.6037
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

k) Trend Test

Dependent Variable: RD
Method: Least Squares
Date: 06/25/10 Time: 18:09
Sample: 1 24
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.069211	0.244629	0.282924	0.7799
@TREND	0.263950	0.018225	14.48276	0.0000

R-squared	0.905070	Mean dependent var	3.104634
Adjusted R-squared	0.900755	S.D. dependent var	1.961847
S.E. of regression	0.618043	Akaike info criterion	1.955139
Sum squared resid	8.403503	Schwarz criterion	2.053310
Log likelihood	-21.46166	Hannan-Quinn criter.	1.981183
F-statistic	209.7504	Durbin-Watson stat	0.872094
Prob(F-statistic)	0.000000		

Cartel Phase

l) Zero Stationarity

Null Hypothesis: RD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.425261	0.5256
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

m) Intercept stationary

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.637367	0.0913
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

n) Trend test

Dependent Variable: RD
Method: Least Squares
Date: 06/28/10 Time: 12:23
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.052069	0.321142	15.73159	0.0000
@TREND	-0.006066	0.005711	-1.062128	0.2926

R-squared	0.019079	Mean dependent var	4.727554
Adjusted R-squared	0.002167	S.D. dependent var	0.766922
S.E. of regression	0.766090	Akaike info criterion	2.337732
Sum squared resid	34.03989	Schwarz criterion	2.407544
Log likelihood	-68.13197	Hannan-Quinn criter.	2.365039
F-statistic	1.128115	Durbin-Watson stat	0.434817
Prob(F-statistic)	0.292580		

d) Correlation between rate of return difference and capacity growth rate changes

Formation Phase

o)

Dependent Variable: DW
Method: Least Squares
Date: 06/25/10 Time: 18:49
Sample (adjusted): 2 24
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000218	0.004657	0.046835	0.9631
RD	-8.42E-05	0.001249	-0.067392	0.9469

R-squared	0.000216	Mean dependent var	-5.46E-05
Adjusted R-squared	-0.047393	S.D. dependent var	0.010803
S.E. of regression	0.011056	Akaike info criterion	-6.088672
Sum squared resid	0.002567	Schwarz criterion	-5.989933
Log likelihood	72.01973	Hannan-Quinn criter.	-6.063839
F-statistic	0.004542	Durbin-Watson stat	3.121374
Prob(F-statistic)	0.946907		

Cartel Phase

p)

Dependent Variable: DW
Method: Least Squares
Date: 06/28/10 Time: 13:12
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006550	0.015696	-0.417292	0.6780
RD	0.001016	0.003278	0.309995	0.7577

R-squared	0.001654	Mean dependent var	-0.001746
Adjusted R-squared	-0.015559	S.D. dependent var	0.019162
S.E. of regression	0.019310	Akaike info criterion	-5.023581
Sum squared resid	0.021628	Schwarz criterion	-4.953769
Log likelihood	152.7074	Hannan-Quinn criter.	-4.996274
F-statistic	0.096097	Durbin-Watson stat	1.655053
Prob(F-statistic)	0.757676		

f) Variance of capacity growth rate changes

Formation Phase

q)

Test for Equality of Variances Between Series
Date: 06/16/10 Time: 16:48
Sample: 1 24
Included observations: 24

Method	df	Value	Probability
F-test	(22, 22)	8514.686	0.0000
Siegel-Tukey		5.690018	0.0000
Bartlett	1	164.8501	0.0000
Levene	(1, 44)	59.43456	0.0000
Brown-Forsythe	(1, 44)	41.91517	0.0000

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
DW_COMP	23	0.996882	0.835274	0.810824	12.21739
DW	23	0.010803	0.008666	0.008615	34.78261
All	46	0.697097	0.421970	0.409720	23.50000

Bartlett weighted standard deviation: 0.704943

Cartel Phase

r)

Test for Equality of Variances Between Series
Date: 06/28/10 Time: 13:15
Sample: 25 84
Included observations: 60

Method	df	Value	Probability
F-test	(59, 59)	2444.019	0.0000
Siegel-Tukey		9.245477	0.0000
Bartlett	1	375.3584	0.0000
Levene	(1, 118)	100.9756	0.0000
Brown-Forsythe	(1, 118)	100.9239	0.0000

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
DW	60	0.019162	0.015547	0.015545	89.86667
DW_COMP	60	0.947308	0.752063	0.752028	31.13333
All	120	0.667287	0.383805	0.383786	60.50000

Bartlett weighted standard deviation: 0.669985

7.3.2 Table VII: Quota Cartel

Quota Cartel

	Cartel Phase II Sample 85-144
a) Utilization rate of capacities	**a)** **b)** **c)**
b) Correlation between utilization rate of capacities and price changes	**d)**
c) Rate of return difference	**e)**
d) Correlation between rate of return difference and capacity growth rate changes	**f)**
e) Distribution of price changes	**--**
f) Variance of capacity growth rate changes	**g)**

Type 2 Quota cartel

Cartel phase II

a) Utilization rate of capacities

a) Zero Stationarity

Null Hypothesis: XD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.504396	0.8216
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

b) Intercept stationarity

Null Hypothesis: XD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.777090	0.3882
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

c) Trend Test

Dependent Variable: XD
Method: Least Squares
Date: 06/28/10 Time: 16:27
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.278506	2.609386	-0.489964	0.6260
@TREND	-0.226362	0.022727	-9.959995	0.0000

R-squared	0.631047	Mean dependent var	-26.97063
Adjusted R-squared	0.624685	S.D. dependent var	4.976491
S.E. of regression	3.048744	Akaike info criterion	5.100101
Sum squared resid	539.1006	Schwarz criterion	5.169913
Log likelihood	-151.0030	Hannan-Quinn criter.	5.127409
F-statistic	99.20149	Durbin-Watson stat	0.436572
Prob(F-statistic)	0.000000		

b) Correlation between utilization rate of capacities and price changes d)

Dependent Variable: DP
Method: Least Squares
Date: 06/28/10 Time: 18:13
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.890345	1.374000	1.375796	0.1742
XD	0.070089	0.050112	1.398637	0.1672

R-squared	0.032627	Mean dependent var	0.000000
Adjusted R-squared	0.015948	S.D. dependent var	1.931014
S.E. of regression	1.915554	Akaike info criterion	4.170656
Sum squared resid	212.8221	Schwarz criterion	4.240467
Log likelihood	-123.1197	Hannan-Quinn criter.	4.197963
F-statistic	1.956184	Durbin-Watson stat	1.845545
Prob(F-statistic)	0.167247		

c) Rate of return differnace

e) Zero Stationarity

Null Hypothesis: RD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.701832	0.0839
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

f) Intercept Stationarity

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.253924	0.6453
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

g) Trend Test

Dependent Variable: RD
Method: Least Squares
Date: 06/28/10 Time: 17:53
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.15379	0.656914	18.50134	0.0000
@TREND	-0.086185	0.005722	-15.06324	0.0000

R-squared	0.796421	Mean dependent var	2.371749
Adjusted R-squared	0.792911	S.D. dependent var	1.686601
S.E. of regression	0.767523	Akaike info criterion	2.341467
Sum squared resid	34.16727	Schwarz criterion	2.411279
Log likelihood	-68.24402	Hannan-Quinn criter.	2.368774
F-statistic	226.9012	Durbin-Watson stat	0.455622
Prob(F-statistic)	0.000000		

d) Correlation between rate of return differnace and capacity growth rate changes

h)

Dependent Variable: DW
Method: Least Squares
Date: 06/28/10 Time: 17:45
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.25311	0.346388	29.60005	0.0000
RD	-1.833732	0.119356	-15.36352	0.0000

R-squared	0.802746	Mean dependent var	5.903961
Adjusted R-squared	0.799345	S.D. dependent var	3.451906
S.E. of regression	1.546264	Akaike info criterion	3.742325
Sum squared resid	138.6740	Schwarz criterion	3.812136
Log likelihood	-110.2698	Hannan-Quinn criter.	3.769632
F-statistic	236.0376	Durbin-Watson stat	0.327736
Prob(F-statistic)	0.000000		

f) Variance of capacity growth rate changes

i)

Test for Equality of Variances Between Series
Date: 06/28/10 Time: 18:27
Sample: 85 144
Included observations: 60

Method	df	Value	Probability
F-test	(59, 59)	2.046913	0.0067
Siegel-Tukey		0.543234	0.5870
Bartlett	1	7.349922	0.0067
Levene	(1, 118)	13.01507	0.0005
Brown-Forsythe	(1, 118)	12.92880	0.0005

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
DW_COMP	60	2.412733	1.885511	1.882839	62.23333
DW	60	3.451906	2.953015	2.950915	58.76667
All	120	4.063695	2.419263	2.416877	60.50000

Bartlett weighted standard deviation: 2.977998

7.3.3 Table VIII Regional Cartel

	Regional cartel		
	Formation Phase Sample 1-24	Cartel Phase I Sample 25-84	Cartel Phase II Sample 85-144
a) Utilization rate of capacities	**a)** **b)** **c)**	**d)** **e)** **f)**	**g)** **h)** **i)**
b) Correlation between utilization rate of capacities and price changes	**j)**	**k)**	**l)**
c) Rate of return difference	**m)** **n)** **o)**	**p)** **q)** **r)**	**s)** **t)** **u)**
d) Correlation between rate of return difference and capacity growth rate changes	**v)**	**w)**	**x)**
e) Distribution of price changes	**--**		
f) Variance of capacity growth rate changes	**y)**	**z)**	**ä)**

Type 3 Regional cartel

a) Utilization rate of capacities

Formation phase

a) Zero Stationarity

Null Hypothesis: XD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.334577	0.9493
Test critical values:	1% level	-2.669359	
	5% level	-1.956406	
	10% level	-1.608495	

*MacKinnon (1996) one-sided p-values.

b) Intercept Stationarity

Null Hypothesis: XD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.756819	0.3911
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

c) Trend Test

Dependent Variable: XD
Method: Least Squares
Date: 06/28/10 Time: 19:43
Sample: 1 24
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.478333	0.839237	-1.761520	0.0920
@TREND	-1.013478	0.062524	-16.20940	0.0000

R-squared	0.922738	Mean dependent var	-13.13333
Adjusted R-squared	0.919226	S.D. dependent var	7.460369
S.E. of regression	2.120296	Akaike info criterion	4.420644
Sum squared resid	98.90442	Schwarz criterion	4.518815
Log likelihood	-51.04773	Hannan-Quinn criter.	4.446689
F-statistic	262.7445	Durbin-Watson stat	0.553717
Prob(F-statistic)	0.000000		

Cartel Phase I

d) Zero Stationarity

Null Hypothesis: XD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.333236	0.5611
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

e) Intercept Stationarity

Null Hypothesis: XD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.959287	0.0447
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

f) Trend Test

Dependent Variable: XD
Method: Least Squares
Date: 06/29/10 Time: 11:32
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-19.23350	1.307570	-14.70934	0.0000
@TREND	-0.033782	0.023253	-1.452808	0.1517

R-squared	0.035113	Mean dependent var	-21.04082
Adjusted R-squared	0.018477	S.D. dependent var	3.148461
S.E. of regression	3.119239	Akaike info criterion	5.145820
Sum squared resid	564.3198	Schwarz criterion	5.215632
Log likelihood	-152.3746	Hannan-Quinn criter.	5.173127
F-statistic	2.110652	Durbin-Watson stat	0.537318
Prob(F-statistic)	0.151666		

Cartel Phase II

g) Zero Stationarity

Null Hypothesis: XD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.978853	0.0465
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

h) Intercept Stationarity

Null Hypothesis: XD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.641460	0.0905
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

i) Trend Test

Dependent Variable: XD
Method: Least Squares
Date: 06/28/10 Time: 18:40
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-26.94476	3.494567	-7.710471	0.0000
@TREND	0.152997	0.030437	5.026701	0.0000

R-squared	0.303452	Mean dependent var	-9.579595
Adjusted R-squared	0.291442	S.D. dependent var	4.850519
S.E. of regression	4.082967	Akaike info criterion	5.684290
Sum squared resid	966.8960	Schwarz criterion	5.754102
Log likelihood	-168.5287	Hannan-Quinn criter.	5.711597
F-statistic	25.26772	Durbin-Watson stat	0.526424
Prob(F-statistic)	0.000005		

b) Correlation between utilization rate of capacities and price changes

Formation Phase

j)

Dependent Variable: DP
Method: Least Squares
Date: 07/02/10 Time: 15:06
Sample (adjusted): 2 24
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.346009	0.734960	1.831404	0.0813
XD	0.034766	0.047878	0.726131	0.4758

R-squared	0.024493	Mean dependent var	0.869565
Adjusted R-squared	-0.021960	S.D. dependent var	1.570881
S.E. of regression	1.588036	Akaike info criterion	3.845814
Sum squared resid	52.95901	Schwarz criterion	3.944553
Log likelihood	-42.22686	Hannan-Quinn criter.	3.870647
F-statistic	0.527266	Durbin-Watson stat	1.980955
Prob(F-statistic)	0.475775		

Cartel Phase I

k)

Dependent Variable: DP
Method: Least Squares
Date: 07/02/10 Time: 15:14
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.455274	1.883061	2.897025	0.0053
XD	0.260346	0.088526	2.940887	0.0047

R-squared	0.129767	Mean dependent var	-0.022617
Adjusted R-squared	0.114763	S.D. dependent var	2.275448
S.E. of regression	2.140902	Akaike info criterion	4.393096
Sum squared resid	265.8407	Schwarz criterion	4.462908
Log likelihood	-129.7929	Hannan-Quinn criter.	4.420403
F-statistic	8.648815	Durbin-Watson stat	2.002605
Prob(F-statistic)	0.004695		

Cartel Phase II

l)

Dependent Variable: DP
Method: Least Squares
Date: 06/29/10 Time: 11:55
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	246.1945	1.371643	179.4887	0.0000
XD	0.859584	0.127960	6.717615	0.0000

R-squared	0.437583	Mean dependent var	237.9600
Adjusted R-squared	0.427886	S.D. dependent var	6.302988
S.E. of regression	4.767467	Akaike info criterion	5.994272
Sum squared resid	1318.267	Schwarz criterion	6.064084
Log likelihood	-177.8282	Hannan-Quinn criter.	6.021580
F-statistic	45.12635	Durbin-Watson stat	0.194141
Prob(F-statistic)	0.000000		

c) Rate of return difference

Formation Phase

j) Zero Stationarity

Null Hypothesis: RD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.334577	0.9493
Test critical values:	1% level	-2.669359	
	5% level	-1.956406	
	10% level	-1.608495	

*MacKinnon (1996) one-sided p-values.

k) Intercept Stationarity

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.756819	0.3911
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Cartel Phase I

l) Zero Stationarity

Null Hypothesis: RD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.529072	0.4835
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

m) Intercept Stationary

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.959287	0.0447
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

n) Trend Test

Dependent Variable: RD
Method: Least Squares
Date: 06/29/10 Time: 11:36
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.191624	0.326893	15.88174	0.0000
@TREND	-0.008445	0.005813	-1.452808	0.1517

R-squared	0.035113	Mean dependent var	4.739794
Adjusted R-squared	0.018477	S.D. dependent var	0.787115
S.E. of regression	0.779810	Akaike info criterion	2.373232
Sum squared resid	35.26999	Schwarz criterion	2.443043
Log likelihood	-69.19695	Hannan-Quinn criter.	2.400539
F-statistic	2.110652	Durbin-Watson stat	0.537318
Prob(F-statistic)	0.151666		

Cartel Phase I

I

o) Zero Stationarity

Null Hypothesis: RD has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.993715	0.9137
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

*MacKinnon (1996) one-sided p-values.

p) Intercept Stationarity

Null Hypothesis: RD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.230323	0.6558
Test critical values:	1% level	-3.544063	
	5% level	-2.910860	
	10% level	-2.593090	

*MacKinnon (1996) one-sided p-values.

q) Trend Test

Dependent Variable: RD
Method: Least Squares
Date: 06/29/10 Time: 11:59
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.745427	0.661986	-1.126045	0.2648
@TREND	0.068983	0.005766	11.96435	0.0000

R-squared	0.711652	Mean dependent var	7.084192
Adjusted R-squared	0.706680	S.D. dependent var	1.428107
S.E. of regression	0.773449	Akaike info criterion	2.356850
Sum squared resid	34.69692	Schwarz criterion	2.426662
Log likelihood	-68.70551	Hannan-Quinn criter.	2.384157
F-statistic	143.1457	Durbin-Watson stat	0.502034
Prob(F-statistic)	0.000000		

d) Correlation between rate of return difference and capacity growth rate changes

Formation Phase

u)

Dependent Variable: DW
Method: Least Squares
Date: 06/28/10 Time: 19:55
Sample (adjusted): 2 24
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002091	0.006140	-0.340500	0.7369
RD	0.000483	0.001600	0.301654	0.7659

R-squared	0.004314	Mean dependent var	-0.000437
Adjusted R-squared	-0.043099	S.D. dependent var	0.012989
S.E. of regression	0.013266	Akaike info criterion	-5.724260
Sum squared resid	0.003696	Schwarz criterion	-5.625521
Log likelihood	67.82899	Hannan-Quinn criter.	-5.699427
F-statistic	0.090995	Durbin-Watson stat	2.374623
Prob(F-statistic)	0.765883		

Cartel Phase I

v)

Dependent Variable: DW
Method: Least Squares
Date: 06/29/10 Time: 11:46
Sample: 25 84
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.026064	0.016936	1.538975	0.1292
RD	-0.005965	0.003526	-1.691915	0.0960

R-squared	0.047033	Mean dependent var	-0.002209
Adjusted R-squared	0.030603	S.D. dependent var	0.021649
S.E. of regression	0.021316	Akaike info criterion	-4.825988
Sum squared resid	0.026353	Schwarz criterion	-4.756176
Log likelihood	146.7796	Hannan-Quinn criter.	-4.798681
F-statistic	2.862578	Durbin-Watson stat	1.798967
Prob(F-statistic)	0.096029		

Cartel Phase II

x)

Dependent Variable: DW
Method: Least Squares
Date: 06/29/10 Time: 12:04
Sample: 85 144
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.782085	1.241578	7.073328	0.0000
RD	-2.065192	0.171860	-12.01671	0.0000

R-squared	0.713440	Mean dependent var	-5.848129
Adjusted R-squared	0.708500	S.D. dependent var	3.491744
S.E. of regression	1.885219	Akaike info criterion	4.138730
Sum squared resid	206.1349	Schwarz criterion	4.208542
Log likelihood	-122.1619	Hannan-Quinn criter.	4.166037
F-statistic	144.4012	Durbin-Watson stat	0.370372
Prob(F-statistic)	0.000000		

f) Variance of capacity growth rate changes

Formation Phase

y)

Test for Equality of Variances Between Series
Date: 06/28/10 Time: 19:57
Sample: 1 24
Included observations: 24

Method	df	Value	Probability
F-test	(22, 22)	5890.100	0.0000
Siegel-Tukey		5.690018	0.0000
Bartlett	1	156.9251	0.0000
Levene	(1, 44)	59.16891	0.0000
Brown-Forsythe	(1, 44)	41.76358	0.0000

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
DW	23	0.012989	0.010491	0.010018	34.78261
DW_COMP	23	0.996882	0.835274	0.810824	12.21739
All	46	0.697117	0.422882	0.410421	23.50000

Bartlett weighted standard deviation: 0.704962

Cartel Phase I

z)

Test for Equality of Variances Between Series
Date: 06/29/10 Time: 11:51
Sample: 25 84
Included observations: 60

Method	df	Value	Probability
F-test	(59, 59)	1914.643	0.0000
Siegel-Tukey		9.213985	0.0000
Bartlett	1	361.0901	0.0000
Levene	(1, 118)	101.0471	0.0000
Brown-Forsythe	(1, 118)	101.0487	0.0000

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
DW	60	0.021649	0.015156	0.014945	89.76667
DW_COMP	60	0.947308	0.752063	0.752028	31.23333
All	120	0.667320	0.383610	0.383486	60.50000

Bartlett weighted standard deviation: 0.670023

Cartel Phase II

ä)

Test for Equality of Variances Between Series
Date: 08/26/10 Time: 20:39
Sample: 85 144
Included observations: 60

Method	df	Value	Probability
F-test	(59, 59)	13.35708	0.0000
Siegel-Tukey		0.784672	0.4326
Bartlett	1	78.98917	0.0000
Levene	(1, 118)	91.84374	0.0000
Brown-Forsythe	(1, 118)	91.10082	0.0000

Category Statistics

Variable	Count	Std. Dev.	Mean Abs. Mean Diff.	Mean Abs. Median Diff.	Mean Tukey-Siegel Rank
DW_COMP	60	0.955403	0.786214	0.786214	63.00000
DW	60	3.491744	3.013561	3.011324	58.00000
All	120	3.903779	1.899887	1.898769	60.50000

Bartlett weighted standard deviation: 2.559792