Organizational diversity and the growth and economic performance of cities
An empirical study in Zwolle, the Netherlands, 1850-1914

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Cities differ dramatically with respect to the extent in which their economic and other activities are diversified. Some cities are specialized, while other cities harbour a myriad of organizations, performing a huge variety of activities. An unanswered question is: Where does such organizational diversity within city communities originate from, and what are its consequences for economic performance and growth? We argue that the extent of organizational diversity goes hand in hand with the fractionalization of the city's resource environment. Specifically, the more heterogeneous the pool of city inhabitants on salient characteristics such as age, gender and religious background, the more organizational diversity can be expected. This is because human population heterogeneity implies variety and preferences of needs, which spurs entrepreneurship and ultimately sustains organizational diversity. Furthermore, we claim that local organizational diversity is beneficial for economic performance and growth, but only up to a certain maximum after which diversity might undermine performance. Cities with an optimal organizational composition have a level of organizational diversity that is high enough to shield it from external exogenous shocks, but not too high to prevent them from reaping externalities resulting from the performance of related activities. In other words, we suggest that cities have to balance technical efficiency and long-run adaptive capacity. In this paper, the above theory will be tested for the city of Zwolle in the Netherlands in the period 1850-1914.

Work in progress
Preliminary model estimations

Paper prepared for the European Regional Science Association Conference
Volos, Greece, August 30th - September 3rd , 2006.

1 Introduction

Dissart (2003) argues that economic diversity should be fostered, since there is a concern that economic cyclical fluctuations could adversely affect industries, workers and their communities. It is usually assumed that economic diversity increases economic stability: that is, the presence of multiple economic sectors in a given region or city reduces employment fluctuations in that region or city. A city may want to specialize in a small number of fast-growing industries, which would be more beneficial on the short term, since this may make rapid growth possible, but the economy may become vulnerable to downturns in the industries in which it specializes. Also Pasinetti (1981) is in favour of the long-tem effect of diversity on the economic system. He argues that an economy that does not increase the diversity of sectors over time will ultimately suffer from structural unemployment and stagnate. The development of new sectors in an economy is required to absorb labour that has become redundant in pre-existing sectors. This diversity of organizations originates from the resource distribution (the pool of the city's inhabitants). When the inhabitants of the city are more heterogeneous, with more heterogeneous tastes, demand and needs, this will spur entrepreneurship en development of new organizations. Therefore, a variety of demand from a diversified resource distribution will create and sustain organizational diversity (Boone, Carroll and Van Witteloostuijn, 2002; Malerba, 2006).

Many studies (e.g. Henderson, 1974, 1997, 2003; Glaeser, 1999, Glaeser et al., 1992; Frenken, Saviotti and Trommetter, 1999; Frenken, Van Oort, Verburg and Boschma, 2005) try to explain the impact of a diversity of organizations within and between sectors on the performance of regions/cities with the use of either or both Jacobs' and Marshall's externalities. In general, the literature presents conflicting evidence about the nature of these scale externalities. While Glaeser (1999) argues for the existence of only Jacobs' externalities, Henderson (1997, 2003) finds that only Marshall's externalities are relevant for traditional manufacturing and for new high tech industries. Moreover, Henderson (2003) finds little evidence of economies from diversity or scale of local economic activities outside the own industry. According to Henderson (2003) a number of productivity studies have attempted to sort out whether local scale externalities are Marshall's externalities from the scale of local own industry activity versus Jacobs' externalities from cross-fertilization enhanced by the scale or diversity of activity outside the own industry locally. Therefore we expect cities to have an optimal organizational composition with a level of organizational diversity that is high enough to shield it from external exogenous shocks, but not too high to prevent them from reaping externalities resulting from the performance of related activities. Regardless whether externalities for a particular industry are Marshall's or Jacobs', there are strong implications for urban development either way. Additionally, Saviotti (1996) has argued that both externalities can occur together and that growth in diversity, leading to new products and sectors, can complement productivity growth in pre-existing sectors. However, little attention has been given to examining the causal relationship between the resource distribution, organizational diversity and city performance within a multivariate framework.

What causes organizational diversity and what are the consequences of organizational diversity on the economic performance of cities? We argue that local organizational diversity is beneficial for economic performance and that organizational diversity is spurred by a heterogeneous resource distribution. This paper will analyze these relationships, determining the causality and direction of the relationships by employing cointegration and vector error correction modelling to test the causal relationships between city performance (CP), resource distribution (RD) and organizational diversity (OD) in Zwolle, The Netherlands, over the period 1851 – 1914.

The objective of this paper is to employ cointegration and error-correction modelling to test the causal relationships. It makes therefore contributions to existing literature in Regional Science by elaborating on the work of among others Henderson (1974, 1997, 2003), Glaeser (1999), Glaeser et al., (1992), Frenken, Saviotti and Trommetter (1999), Frenken, Van Oort, Verburg and Boschma (2005). These studies focus on the regional and/or national level and/or on one or more related sectors within one city or region on considerable shorter time frames than the current investigation. The current investigation adds three distinct contribution to the existing literature. First, a much longer term investigation in the evolution of the diversity or specialization of a city. Second, the use of sophisticated models to investigate the relationships and third, the investigation of both externalities and the resource distribution to explain this organizational diversity. Dissart (2003) argues that especially research on the long-term relationship between economic diversity and performance is scarce but of major importance. A combination of a historical long term study of urban phenomena to investigate these relationships with the sophisticated econometric techniques to determine Granger- causality has not been done in this way yet.

The paper is organized as follows. The next section provides an overview of the conceptual arguments about the relationships between the three variables and reviews the existing empirical evidence. The data and time frame are considered in section three followed by a section on diversity indices. The econometric methodology and results are set out and discussed in section five. The paper concludes with conclusions and discussions in section six.

2 Literature review

This section elaborates the theoretical arguments in investigating causal relationships between resource distribution (RD), organizational diversity (OD), and city performance (CP). We will briefly review relevant literature and present an overview of the conceptual arguments about the possible relationships from earlier empirical research.

2.1 The relationship between RD and OD

The starting point of the proposed model of causal relationships is the resource distribution within the city. Examples of such can be found in the urban demography as the composition of the urban population; ethnicity, gender, age, educational levels, religious denomination et cetera. When this distribution of salient characteristics becomes more fragmented, the city can be expected to have a larger diversity of organizations. After all: a more heterogeneous population is accompanied by more heterogeneous needs, which have and must be satisfied by a plentiful collection of very diverse organizations. Organizational logic explains how the structure of the organizational population is connected with the local resource distribution (Van Witteloostuijn and Boone, 2006). An example is the study of a single industry from Boone, Carroll and Van Witteloostuijn (2002). This study finds that a concentration of dominant newspapers decreases when the potential group of readers gets more heterogeneous considering age, education, political affiliation and religious denomination. There became a need for more different newspapers, so a wider and more assorted range of newspapers appeared. In this study the resource distribution was composed along dimensions of age, education, religion and political preference.

Also other studies find relationships between the resource distribution and the diversity of a organisational population. Duranton and Puga (2000) for example argue that patterns of specialization and diversification of cities merely mirror the spatial distribution of resources. When the resources are reflected or measured by taste and demand of the city inhabitants, one can use the following arguments. Standard economic analysis claims that demands provides incentives to innovation during industry evolution, since consumer behaviour plays an important role in affecting innovations and can create market opportunities for new entrepreneurs and firm entries (Malerba, 2006). Malerba (1985; 2006) argues that diversity in demand drives specific stages of the evolution of an industry. Pasinetti (1981), Dosi (2001), and Saviotti (1996) link innovation and industry evolution in structural change and the changing sectoral composition of the economy. Combining this with the arguments found by Adner and Leventhal (2001); the presence of consumers with different needs and requirements influenced the evolution of technology. Market demand, as in consumer differences, with an underlying inherent diversity creates diversification in firms. The resource base in this paper is seen as dimensions of customer taste preferences (compare Péli and Nooteboom, 1999). Also Peterson and Kern (1996) find that people with higher education, older age and higher income have different tastes than people with lower education, younger age and less income. Also Malerba (2006) finds that various types of customers are present due to heterogeneity of the inhabitants. Each customer has different needs, so due to customers with different preferences and demands, it permits new technologies effectively to grow either within established firms or through new firms. On the long run this causes a profound effect on the structure and composition of the organizational population. Mostly this concerns the diversity within sectors, such as Swaminathan (1995) that found that the change in the population of the wine industry could be explained by changes in consumer preferences and by the complex interdependencies that can exist between organizational subpopulations within the wine sector. Delacroix and Sort (1988: 54) argue that new niches in the wine industry evolved out of changes in lifestyle and consumer preferences. Therefore, more heterogeneous needs and demand spur the development of new (forms of) organizations and therefore creates more organizational diversity.

Well known are the arguments of Jacobs (1969) and Bairoch (1988) that both argue that the cramming of individuals, occupations and industries into close quarters provides an environment in which ideas flow quickly from person to person creating business opportunities and more diverse range of businesses. Alesina and Le Ferrara (2006) argue that an mix of inhabitants in a city brings also variety in abilities, experiences and cultures which may be productive and may lead to innovation and creativity. While much evidence points towards the problem of racial heterogeneity in US cities, they find that the racially mixed and racially troubled NYC and LA are constant producers of innovation in the arts and new businesses.

So therefore on the community level, organizational diversity can be explained following the same logic; start and end of industries and industry internal change by new technology and processes. The underlying mechanism is the resource-distribution within the community and their taste and needs. When the resource distribution gets more heterogeneous, more and diverse organizations are needed to fulfil the demand of the population. Diversity can create potential benefits by increasing the variety of goods, services and skills available for consumption and production (Florida, 2002, Ottaviano and Peri, 2005) Combining these insights it can be argued that more diversity in the resource distribution leads to more diversity of organizations.

2.2 The relationship between OD and CP

The next step considers the influence of such a diversity of organizations on urban (economic) performance of a city. Saviotti (1996) argues that the national diversity of organizations has a positive consequence for the macro-economic performances of a country. Building forth on the early work of Jacobs (1969) the same effect can be expected to occur in cities. After all, cities with a large diversity of organizations have an enormous evolutionary selection at their disposal. At this level both Jacobs' and Marshall's externalities play a role at the process of either diversifying or specializing of industries and hence the city's population of organizations. According to Frenken et al. (2005) when one follows the new growth theory, urban and regional economic growth are caused mainly by spillovers. A question that arises though, is whether these spillovers occur primarily when a city is specialized in a few sectors (Marshall or localized economies) or diversified in a large variety of sectors (Jacobs' externalities). In principle both can occur as a result of spillovers, as firms can learn from firms in the same industry (Marshall's externalities) or from firms in other sectors (Jacobs' externalities). They conclude that for growth benefits from either Marshall's or Jacobs' externalities, the composition of the organizational population is at hand - since spillovers occur between firms within a sector but also between firms of different sectors. Following this argument, the present diversity in an economy can be an additional source of economic growth (Jacobs, 1969; Glaeser et al., 1992, Van Oort, 2004).

Many studies have been done about the role of externalities and the development of urban areas since dynamic externalities form the underpinnings of endogenous growth processes. Cities provide a natural laboratory to study dynamic externalities, because they facilitate communications among economic agents (Henderson, 1997). If an industry is subject to just Marshall's externalities, producers are likely to cluster together primarily, specializing in just that activity, or closely interconnected set of related activities and creating short term economic growth (Dissart, 2003; Henderson, 2003). Specialization or concentration enhances full exploitation of scale externalities, while conserving on local land rent and congestion cost increases. However, if an industry is subject more to Jacobs' externalities, there is a need to be more diverse, and hence increase the diversity of the local environment (Glaeser, 1999; Henderson, 1997). Upgrading these dynamics to the level of a city, one can argue that Jacobs' externalities generate more diversity between sectors in the city and determine long-term growth (compare Dissart 2003; Pasinetti, 1981), while Marshall's externalities create just more of the same organizations within one sector, and cause a city to concentration in a specific number of sectors and is mostly beneficial for short term city performance (Dissart, 2003). Here is the distinction between these two externalities as proposed by Hoover (1948) and Isard (1956) applied. Marshall's externalities cause external economies available to all local firms within the same sector and therefore has a negative effect on the organizational diversity in the city and cause short term city growth and Jacob's externalities cause external economies available to all local firms irrespectively of sector to all local firms, which have a positive effect on the overall city diversity and long term economic growth. This is also argued by Henderson (1997) that with just Marshall's externalities, cities are likely to concentrate in just that one activity, or closely connected set of activities. However, when the city is subject to Jacobs' externalities, the urban environment diversifies. In Jacobs' (1969) view economic diversity is the key factor of a city's success. Jacobs argues that it is a self reinforcing phenomenon: city diversity itself permits and stimulates more diversity. Sassen (1994) studies global cities and their strategic role in the development of activities that are central to world economic growth and innovation. A key feature of Sassen's cities is the cultural diversity of the economic populations causing the global role. Bairoch (1988) sees cities and their diversity as the engines of economic growth. Such diversity, however, has been seen mainly in term of the diversified provision of consumer goods and services, as well as productive inputs. Here the standard assumption is that higher diversity can lead to more innovative and creativity and therefore enhance city growth. Also the findings from Glaeser et al.(1992) underline this, who found a positive relationship between Jacobs' externalities and increased city performance. Therefore, one could expect that in the shorter term Marshall's externalities play a stronger role in the city creating it to concentrate on one or a few sectors and on the long run the a specialized city increases the risk of unemployment and a growth slowdown. On the long term Jacobs' externalities create a rather even distribution of the organizations over all city sectors, which will reduce unemployment and would promote economic growth, while specialization would in the long-term create the opposite effect (Pasinetti, 1981).

Summarizing, on the city level it can be argued that the level of diversification of organizations, caused by both Jacobs' and Marshall's externalities, has a influence on city performance. Marshall externalities – concentration – on the short run and Jacobs' externalities – diversification – on the long run. In the long run one can argues that an increase in diversity in kind of organizations leads to an increase of city economic performance up to a certain level. This is created by Jacobs' externalities (diversity and generalization), that is fed by a heterogeneous resource distribution. The diversity index to measure these effects will be elaborated in section 4. We can argue from the above that cities with an optimal organizational composition have a level of organizational diversity that is high enough to shield it from external exogenous shocks, but not too high to prevent them from reaping externalities resulting from the performance of related activities. When the diversity of organizations[1] get higher, the performance of the city is expected to increase as well.

2.3 The relationship between CP and RD

Furthermore, from an economic perspective, another prominent question is what is more productive and affluent; a culturally homogeneous society or a culturally diverse

[1] An important issue concerning diversity on the level of organizations is that Henderson (2003) finds in all his cases that average employment per plant does not positively contribute to productivity. This suggests that externalities derive from the existence of organizations per se. Organizations could be interpreted as separate sources of information spillovers as done in Fujita and Ogawa (1982), so externalities are related to the count of such forms, with unemployment size of the sources being unimportant. Therefore one can study all organizations within a city at the same time.

one? The answer to this question is not obvious. On the one hand cultural diverse city population can generate costs from potential conflicts of preferences, hurdles to communication, or outright racism, prejustice of fear of other groups, leading to sub-optimal provision of private and public goods (Alesina and La Ferrara, 2006). On the other hand, such cultural diversity can create potential benefits by increasing the variety of goods, services and skills available for consumption and production. Moreover by bringing together complementary skills, different abilities and alternative approaches by problem solving, diversity may also boost creativity, innovation and ultimately growth (Florida, 2002, Ottaviano and Peri, 2003). Resource diversity stimulates city dynamics and city dynamics gives in return an impulse to resource diversity. The exact relationship is not clear at this moment. If it is perceived as a feedback mechanisms as such, it is crucial for the adaptive abilities and the viability of the (community of) populations (Campbell, 1969). Above average urban performance can attract immigration (Sharma, 2003), which in turn creates a further increase in the heterogeneity of the resource distribution. This is turn feeds the ecological cycle by furthering organizational diversity. However, the research from Alesina and Le Ferrara (2006) and Ottaviano and Peri (2003) indicate also a direct relationship between resource distribution and city performance. Ottaviano and Peri (2005) studied the cultural diversity across US cities. Diversity of cultures implies in their study a diversity of production skills, abilities and occupations that enhances the productive performance of a city. They find that wages and employment density of US born workers were systematically higher in cities with richer linguistic diversity. Ottaviano and Peri use data on rents and wages in US cities and find that US born individuals living in more culturally diverse cities earn higher wages and pay higher rents than those living in more homogeneous cities. In other words, diversity of the resource distribution has a positive amenity effect on production and consumption in a city.

Several authors argued among similar lines about how the functioning and thriving of urban clusters relies on the variety of people, factors, good and services within them. For example, Florida (2002) argues that amenities and diversity in US cities attracts human capital. He constructs imaginative indices of heterogeneity of a place that are not directly related to ethnicity but involve proportions of gay households, diversity of night life, etc. and finds that places that score higher in these indices have also higher levels of human capital. According to Ottaviano and Peri (2003) it is not obvious whether Florida's relationships are in the correct direction, they can as easily be explained the other way round. Sharma (2003) and Blanchard and Katz (1992) find that population growth is a correct measure to use to capture areas and cities that are becoming increasingly more attractive economically and as a place to live in. Blanchard and Katz, have noted that migration within the US responds strongly and relatively quickly to income opportunities in cities. Florida (2002) argues that amenities and diversity in US cities attracts human capital. So, when a city performs well, it attracts more immigrants.

The diversity of organizational forms in a social system determines societal outcomes, the diversity of producers and associated products in a market might affect consumption patterns and vice versa. A diversified city with standing city performance will attract more immigrants, which will increase the diversity in resource distribution. A city is considered successful when the immigrants stay (Kooij, 1988). Alesina and Le Ferrara (2006) argue that an ethnic mix also bring about variety in abilities, experiences, cultures which may be productive and may lead to innovation and creativity. While much evidence points towards the problem of racial heterogeneity in US cities, they find that the racially mixed and racially troubled NYC and LA are constant producers of innovation in the arts and new businesses. The findings above indicate that the relationship between resource distribution and city performance balances between in two directions.

3 Data: the case of Zwolle

The variables investigated in this paper are city performance (CP), organizational diversity (OD) and resource distribution (RD) and one control variable Real Gross Domestic product (GDP) for the period 1851 – 1914 in the city of Zwolle, in the Netherlands. This section will elaborate on the choice of Zwolle to investigate the proposed relationships.

The choice to investigate these variables at the level of a city links directly to the use of Organizational Ecology logic for the distribution of resources. The differences that play part in multiple populations is best conceptualized at the level of the Organizational Ecology community (in this paper the community is the city), where the activities of one kind of organization create new resource possibilities for other organizations (Ruef, 2000). When studying the interactions of populations of organizations, there are two approaches in community ecology: either describing the boundaries of the community by geographical criteria or by functional criteria (McKelvey and Aldrich, 1983). When applying the first approach - defining the community at the boundary of a city, the ecological approach of this level of a community requires the gathering of data on the relative densities of various organizational populations within this specific city within the specific period (Ruef, 2000). The choice for this geographical boundary for a community study depends mostly on the (historical) period of investigation. When researching a preindustrial or industrializing era – where the scope of communication and transportation network was relatively limited – local boundaries are often appropriate for community ecologies (Aldrich, 1999; Ruef, 2000). The period 1850 -1914 in the Netherlands was a era of industrialization (De Jonge, 1968) and therefore we can study the city of Zwolle in this period as a city with a single and autonomous community of organizations.

In the period under study, the city of Zwolle can be defined as a city of regional economic importance, even though the scale of the city remained relatively small. The period 1851 - 1914, represents the start of the industrial revolution in the Netherlands up to the start of World War I. This era is characterized by a large economic transition from mainly agricultural, crafts and trade to more industrial and mechanized production (De Jonge, 1968, Brouwer, 2005). This transition period guarantees that diversity and emergence of new organizations and sectors does happen, also in Zwolle, to enable a study into organizational diversity. Ten Hove (2005) describes this transition period for Zwolle as constant progress, however, without extremes. According to Ten Hove, in Zwolle most change was to be seen in education, health and transportation sectors. Due to a lack of protoindustry before the 1850s (Kooij, 1988), Zwolle never turned into a full mechanized production city (as compared to cities that focused mainly on the industrialized production in one sector, such as Tilburg and its textile industry). Zwolle got connected to the main rail way system in 1869, which made the city the transportation node between the centre of the Netherlands and the more peripheral north. Zwolle's focus on service oriented sectors became even more apparent after this connection.

The data we use in this paper comes from the historical archives of the province of Overijssel, in the Netherlands, in which Zwolle is the regional capital. Most data comes from the annual reports from the municipality (*Verslag van den toestand der gemeente Zwolle over het jaar 1851 – 1914),* and complemented with the decennial census in the Netherlands in the corresponding period (*tienjarige volkstelling in het koninkrijk der Nederlanden),* and the alphabetical register of taxes (*Klassikaal alphabetisch register op het kohier van de hoofdelijken omslag, zoo als het door Burgemeester en Wethouders voorloopig is vastgesteld).* The Dutch GDP over this period comes from the Dutch national accounts 1800-1913 (website NIWI).

The variables are measured as follows: city performance is the normal income of the municipality of Zwolle as a proxy for the performance for the entire city. The organizational diversity is measured in a Shannon diversity index on the population of private organizations in this period (a more elaborate discussion of diversity in the following section).. The public organizations are excluded for the moment, since those are less than 5% of the entire population of organizations in all years in the period under investigation. The resource distribution is measured as the average of four inverse Hirschman-Herfindahl indices, measuring the diversity of sex, age, education and religious denomination; the salient characteristics of the city's inhabitants (following Boone et al., 2002). As a control variable is chosen the Dutch GDP, with the underlying assumption that when the national performance of the Netherlands goes up, also the performance of Zwolle should go up (see figure 1).

4 Diversity indices

In the field of Biology the diversity of a community is in large part a function of the total number of species it may contain (species richness), but also of the distribution of individuals between those member species (evenness). For example, when a community consisting of 19 different species all present in low numbers and a 20e species which is extremely abundant, dominating the entire structure and dynamics of the resulting assembly may be considered less diverse than an equivalent system in which the same 20 species are all more equally represented within the community (Putman, 1994; Magurran, 2004). It is therefore, that a measure of diversity must embrace both indications: richness and evenness. In terms of organizational populations the two dimensions of diversity can be defined (compare Magurran 2004), as follows. Evenness is simply a measure of how similar sectors are in their abundance; the number of organizations per sector. Imagine a city where most sectors are equally abundant, it is one with very high evenness (here seen as Jacobs' externalities). Now imagine a city with a very high dominance (the obverse of evenness) meaning that a few sectors have very high abundance and the others have very low abundance, caused in a city by Marshall's externalities. Since in Biology it is convention to equate high diversity with high evenness, we will keep the same assumption. The distribution of abundance of sectors has the power to shed light on the processes that determine the diversity of a community. This stems from the biological assumption that the abundance of a species to some extent at least reflects its success in competing of limited resources (in this case, the resource distribution, which in a given year in a given city is finite). On the other hand there is diversity in richness, which simply is the number of sectors given in the chosen city.

Summarizing, not just the number of sectors is of importance, but also the number of organizations per sector is important in measuring diversity. This was also discussed in section 2; when organizations are more concentrated in a few sectors, the city might benefit from higher Marshall's externalities, whereas when the organizations are present in more sectors in a more even distribution, the city might benefit from higher Jacobs' externalities[2], which is positive for long term city performance. The effect of diversity should therefore ideally be investigated with different measures of diversity that either pays more attention to richness or to evenness when investigating the influence of both externalities on city performance. MacArthur (1972) suggested in Biology than an increase in the abundance of all resources would give an overall increase in production which might lead to an increase in diversity (richness). When we bring this assumption to the level of cities and organizational populations one can say that increasing resources diversity and increase of resources creates more diversity in the number of organizational richness, so Jacob's externalities.

Diversity can be measured in many ways. A simple measure would be to measure just the richness (number of sectors or subsectors in the population), yet this measure leaves much information out. Next to species richness, the division of members of the populations over the several species is also important: evenness (the number of organizations per sector). The more even this distribution is, the more diverse is the population. To capture both dimensions of diversity, several diversity indices have been developed mainly in the field of biology. These indices all measure diversity, but gave either more weight to richness or evenness. Following Magurran (2004) and Krebs (2001) a distinction can be made between the following indices, applied to the city investigation as given below:

The Simpson index, D

This is a widely used diversity index, for a finite community, the formula is as follows:

$$D = \sum \frac{n[n-1]}{N[n-1]}$$

n stands for the number of organization in a certain sector and N for the total of all the organizations in the city in a specific year. Note that the calculation method corresponds to the Hirschman-Herfindahl index commonly used in the field of economics. The range of *D* is 1/ (number of sectors) to 1, and higher values of *D* correspond to lower levels of diversity. In essence it captures the variance of the species abundance distribution (evenness) and *D* is less sensitive to sectoral richness.

Indices related to the Simpson index

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[2] Note, however that the difference between Jacobs' externalities and Marshall externalities is rather arbitrary and to depend on the choice of the level of aggregation and the choice of sectors and sub sectors. And indeed at one level of aggregation a group of organizations may be seens as one sector, it might seen as a group of subsectors on another level of aggregation. Still, both externalities do describe different mechanisms, concentration and diversity, although the effects will probably differ for different levels of aggregation (compare Burggraaf, 2006)

Three often used diversity indices are related to Simpson's D. The first: *ID*: this is simply *ID = 1-D,* meaning a higher value corresponds to a higher level of diversity. The range is between 0 and 1 minus (1/number of sectors). The second: RD, this index is calculated by *RD = 1/D*, also meaning a higher value corresponds to a higher level of diversity. The range is 1 to the number of sectors. The third related index is *Simpson's E.* This index has most emphasis on measuring the evenness dimension of diversity. *E* is calculated as follows: $E = 1/D * 1/S$, where S is the number of sectors in the population and a higher measure of *E* corresponds to a more even distribution, the range between 1/S and 1. The Simpson's Diversity indices are used very often, but are considered to be mostly measuring evenness, and are strongly influenced by the most abundant sectors (indicating more emphasis on Marshall effects).

The Shannon index

This index originates from the field of information theory and can also be called the entropy index. It is calculated as follows: $H = \sum p_i \ln p_{i.}$, where p_i is the proportion of sector *i* with respect to the population. An increase of *H* means diversity is higher. *H* is influenced by sample size, but captures relatively well both dimensions of diversity by making the distinction between the entropy of a system and the effective number of elements of a system (Jost, 2006).

Fisher Alpha index

Alpha is calculated using the following formula: $\alpha = N (1- x) / x$, where a higher value of α indicates higher diversity, where N stands for the number of organizations; *x* is calculated using an iterative procedure to find the solution for:
$S/N = ((1- x) / x) * (-\ln(1- x))$, Fisher's Alpha is an attempt to mathematically describe the relationship between the number of species and the number of individuals. α is relatively unaffected by samples size once $N > 1000$.

These different indices all measure diversity although with different emphasis on either evenness or richness. The Simpson index is considered to be a 'dominance' index, and is strongly influenced by the most abundant sectors (indicating more emphasis on Marshall effects), whereas Simpson's E measures mostly evenness (more emphasis on Jacobs' effects). The Shannon index has a bit more emphasis on evenness, but the index does give the relevant weight to richness. Alpha, on the other hand, is not strongly influenced by the dominant sectors or organizational richness, but more by the intermediate categories. Alpha is relatively insensitive to the most and least abundant sectors. In most research on diversity, Simpson's D or Fisher's alpha are chosen, because the performance of both is well understood and are intuitively meaningful (Magurran, 2004) . In our sample the sample size is > 1000, therefore Fishers alpha is too much influenced by changing sample sizes and therefore less useful. We do not choose any of the Simpson's indices, since they give too little importance to richness (Smith and Wilsons, 1996). We chose the Shannon index, since it is a very common used index in measuring diversity (and therefore easy in comparisons) and because Shannon's index accounts for both abundance and evenness of the sectors. According to Smith and Wilsons (1996) Shannon's index does meet the following requirements which we need in the current investigation: 1) the measure decreases if the abundance of the least abundant sector reduces, 2) the measure will decrease if a new very small (in abundance) sector is added to the community and 3) the measure is unaffected by the units used to measure it.

5 Unit roots, cointegration and Granger causality

The econometric methodology and results are set out and discussed in section five. A three stage procedure was followed to test the direction of causality; this section will present the methods and results according to these three steps. From here forward the following abbreviations are used. CP for city performance, OD for organizational diversity, RD for resource distribution and GDP for gross domestic product. The analysis was done with the statistical package Eviews 5.1.

5.1 Unit root test

The first step of our analysis is to test the order of integration by using the Augmented Dickey-Fuller (ADF) unit root test. Table 1 report the results for the unit root test. The ADF statistics for the level of CP, OD and RD do not exceed the critical values (automatically generated by Akaike Information Criterion and in absolute terms). However, when we take the first difference of each of the variables, the ADF statistics are higher than their respective critical values. Therefore, we can conclude that [OD_t, RD_t, CP_t] are each integrated in order one or $I(1)$. The series are proven to be non-stationary, therefore we can not apply ordinary time series methodology and therefore decided to test the data in a vector error correction model (VECM). By means of Vector Auto Regression Systems (VAR) we first determined the maximum number of allowed lags, followed by a cointegration analysis to determine the cointegrating vectors and the constraints and trends. After this we model the VECM, also testing for Granger causality (compare methodology used in Zhang, Jacobs and Van Witteloostuijn, 2006). Important is to remember that, however, that the conventional Granger-causality test is based on a standard VAR-model defining conditions on the assumption of stationarity. If the time series are non-stationary, the stability condition necessary for VAR is not met, implying that the Wald test statistics for Granger-causality are invalid. In this case, the cointegration approach and vector error correction model (VECM) are recommended to investigate the relationships between non-stationary variables (e.g., Toda and Philips, 1993). Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables.

5.2 Cointegration

The second step involves testing for the existence of a long run equilibrium relationships between CP, OD and RD within a multivariate framework, with as a exogenous control variable GDP. In order to test for the existence of any long-run relationship among the variables, we investigate the existence of a long-run relationship by first creating a VAR to determine the maximum number of allowed lags. The VAR will be re-modeled into a VECM in due course. The Vector Auto Regression (VAR) system treats all variables symmetrically. In terms of the variables central to the present study, the VAR system has the following form:

$$RD_t = a_1 + \sum_{i=1}^{n} b_{1i} RD_{t-i} + \sum_{i=1}^{n} c_{1i} OD_{t-i} + \sum_{i=1}^{n} d_{1i} CP_{t-i} + e_{1t} \,,$$

$$OD_t = a_2 + \sum_{i=1}^{n} b_{2i} RD_{t-i} + \sum_{i=1}^{n} c_{2i} OD_{t-i} + \sum_{i=1}^{n} d_{2i} CP_{t-i} + e_{2t} \,, \text{ and}$$

$$CP_t = a_3 + \sum_{i=1}^{n} b_{3i} RD_{t-i} + \sum_{i=1}^{n} c_{3i} OD_{t-i} + \sum_{i=1}^{n} d_{3i} CP_{t-i} + e_{3t} \,,$$

where *a*, *b*, *c*, and *d* are parameters; the *e*'s are error terms; and *n* is the order of the VAR, *i.e.*, the maximum number of lags in the system. For the $\{CP_t\}$ sequence to be unaffected by resource distribution, all the b_{3i} must be equal to zero; and for the $\{CP_t\}$ sequence to be unaffected by organizational diversity, all the c_{3i} must be equal to zero. Similar logic applies to $\{OD_t\}$ and $\{RD_t\}$. The maximum number of lags that came forward form this procedure is 2 (see table 2). Before we test causality in a VECM, we first have to apply Johansen's test of cointegration.

The purpose of the cointegration test is to determine whether a group of non-stationary series is cointegrated or not. The presence of a cointegrating relation forms the basis of the VEC specification. The program used in this analysis (Eviews) implements VAR based cointegration tests using Johansen's methodology (1991, 1995), therefore Granger's representation theorem asserts that if the coefficient matrix Π has reduces rank $r < k$, then there exist $k \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is I(0), r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. The elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate the Π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of Π. Table 2 gives the results of the Johansen's cointegration test, and we find that this system has one cointegration equation, with the use of 2 lags. Trace statistics and *L*-max statistics indicate that the null hypotheses of no cointegration, $r=0$ is rejected at the 5% level, and the hypothesis for one cointegration vector, $r = 1$, is not rejected. Consequently, we conclude that there is one cointegrating relationship among the three selected variables in the model. Based on the results in Table 3, the cointegration equation is: CP = - 2382.469 OD – 68710.20 RD

The long term equilibrium gives unexpected results. The results indicate a long-run negative relationship between CP and OD, and a long run negative relationship between CO and RD. These relationships imply that when Zwolle's CP goes up, this has a strong negative effect on OD in the long term. With increasing city performance the diversity of the city's organizations goes down, meaning that city performance in the long term goes up by specializing in a few sectors. Also the expected relationship between increasing city performance attracting more immigrants that would spur more heterogeneity in the resource distribution seems to be the other way round in the long term equilibrium. Before we draw any firm conclusions, we should first investigate if the short-term relationships do also differ in this respect. Although the cointegration implies negative relations between the variables, cointegration tests cannot determine the direction in which causality flows. The causality relationships can be ascertained from performing Granger-Causality tests that incorporate the cointegration relation.

5.3 Granger causality

The third stage involves constructing standard Granger-type causality test augmented with a lagged error-correction term where the series are cointegrated. Thus, the Granger causality test involves specifying a multivariate *p*th order VECM as follows: The existence of one cointegration relationship among [OD_t, RD_t, CP_t] suggests that there must be Granger Causality in at least one direction, but it does not indicate the direction between the variables. The basic principle of Granger (non)causality is to test whether or not lagged values of one variable help to improve the explanation of another variable form its own past. Granger Causality is technique for determining whether time series is useful in forecasting another. A time series X is said to Granger Cause Y is can be shown, though a series of F tests of lagged values of X (and with lagged values of Y also known) that those X values provide statistically significant information on future values of X. In other words, x_t is Granger caused for y_t if x_t helps predict y_t at some stage in the future. When x_t Granger causes y_t, and y_t Granger causes x_t there is a feedback system. Granger causality measures whether one thing happens before another thing and helps to predict it – and nothing else.

The long-run relationship in this study cannot determine the direction of causality, though. The direction of the causality can be obtained by estimating a VECM that explicitly includes the cointegrating relationship. In a VECM, long and short-run parameters are separated, which gives an appropriate framework for assessing the validity of the long-run implications of a theory, as well as for estimating the dynamic processes involved. The short-run dynamics of the model are studied by analyzing how changes in each variable in a cointegrated system respond to the lagged residuals or errors from the cointegrating vectors and the lags of the changes of all variables. Therefore, by adopting of the cointegration approach and corresponding VECM, detect both long-run and short-run relationships between non-stationary variables can be found.

In the current study, we found one cointegration relationship between resource distribution, organizational diversity and city performance. Hence, we estimate the following three-equation VECM to analyze causality:

$$\Delta RD_t = \alpha_1 + \alpha_R ect_{t-1} + \sum_{i=1}^{n-1} \beta_{1i} \Delta RD_{t-i} + \sum_{i=1}^{n-1} \gamma_{1i} \Delta OD_{t-i} + \sum_{i=1}^{n-1} \delta_{1i} \Delta CP_{t-i} + \theta_1 GDP + \varepsilon_{1t},$$

$$\Delta OD_t = \alpha_2 + \alpha_O ect_{t-2} + \sum_{i=1}^{n-1} \beta_{2i} \Delta RD_{t-i} + \sum_{i=1}^{n-1} \gamma_{2i} \Delta OD_{t-i} + \sum_{i=1}^{n-1} \delta_{2i} \Delta CP_{t-i} + \theta_2 GDP + \varepsilon_{2t}, \text{ and}$$

$$\Delta CP_t = \alpha_3 + \alpha_C ect_{t-1} + \sum_{i=1}^{n-1} \beta_{3i} \Delta RD_{t-i} + \sum_{i=1}^{n-1} \gamma_{3i} \Delta OD_{t-i} + \sum_{i=1}^{n-1} \delta_{3i} \Delta CP_{t-i} + \theta_3 GDP + \varepsilon_{3t},$$

where ΔRD, ΔOD and ΔCP are first differences of RD*,* OD and CP respectively and GDP is the exogenous control variable; the error-correction term *ect* is a vector of residuals from the long-run equilibrium relationships; α, β, γ , δ, and θ are parameters; and the ε's are error terms. The series in the analyses may have nonzero means and deterministic trends as well as stochastic trends. Similarly the cointegrating equations may have intercepts and deterministic trends. The error-correction terms reveal the deviations from the long-run relationships between the three variables. The coefficients of *ect*, α_F, α_E, and α_I, reflect the speed of adjustment of RO, OD and CP toward the long-run equilibrium. For example, the larger the first (second) element of α_F , the greater the response of CP to the previous period's deviation from the first (second) long-run equilibrium relations. Conversely, if the two elements of α_F are equal to zero, CP does not respond to lagged deviations from the long-run equilibrium relationships. In this case, CP is called weakly exogenous for the system. So, Granger-non-causality in case of cointegrated variables requires the additional condition that the speed-of-adjustment coefficients are equal to zero. For example, for the $\{CP_t\}$ sequence to be unaffected by OD, not only all the β_{3i} must be equal to zero, but also the elements of vector α_c.

Secondly, two deterministic components – a constant and a trend may enter the VECM system. The form in which the constant and the trend enter the VECM is found as part of the cointegration estimation strategy. Given the existence of one cointegrating relationship, we test for weak exogeneity and Granger-causality by using the VECM. In line with the outcomes of the cointegration test, the order of the VECM is one, and a linear trend and cointegrating relations with constants are included in the model.

The concept of weak exogeneity was introduced to justify considering some variables given (exogenous) in the analysis of other (endogenous) variables. It is important to emphasize that weak exogeneity is also a statistical concept and as such can be tested against the data (Johansen, 1992). Johansen (1992) shows that under weak exogeneity single-equation estimation remains efficient in a cointegrated system, whereas if weak exogeneity fails, then system modelling is needed despite the super consistency of estimators in I(1) processes. The test of weak exogeneity of the parameters determines whether the variables react to a disequilibrium. Table 3 reports the results of the weak exogeneity test.

In line with the outcomes of the cointegration test, the order of the VECM is two, Again, GDP is taken on board as an exogenous variable. Weak exogeneity is rejected for CP at the 5%-level. However, weak exogeneity is not rejected for OD and RD. Therefore, there can be a granger causality related with CP. This conclusion is complemented by the result of the VECM Granger-causality test, as displayed in Table 5. Displaying χ^2 (Wald) statistics for the joint significance of each of the other lagged endogenous variables and the error-correction term in the associated equation. In table 5, on can see that there is not much evidence for short term relationships in the system. The hypothesis that OD does not granger causes CP is rejected at the 5% level. All other hypothesis about variable x do not Granger cause another variable are not rejected. In summary, the Wald test statistics indicate a one-way causal link in the short-term dynamics runs from ΔOD to ΔCP.

6) variance decomposition

Detecting Granger causality is restricted to essentially within sample tests, which are useful in discerning the plausible Granger exogeneity of endogeneity of the dependent variable in the same period, but are unable to deduce the degree of exogeneity of the variable beyond the same period. To examine these issues we consider the decomposition of variance, which measures the percentage of a variable's forecast error variance that occurs as the result of a shock from a variable in the system. Sims (1980) notes that if a variable is truly exogenous with respect to the other variable in the system, own innovations will explain all the variable's forecast error variance. Thus the variance decomposition provides information about the relative importance of each random innovation in affecting the variables. The variance decomposition at horizon h is the set of R^2 values associated with the dependent variable y_t and each of the shocks h periods prior. In other words, we use our estimates to decompose the variance of Y into: the part that can be explained by X and the part that cannot be explained by X and therefore should be attributed to other factors.

The variance decomposition results are summarised in table 5 over a 10 year period. With variance decomposition, each column shows how much percentage of the total variance is explained by each component. The variance decomposition results are consistent with the earlier findings in this paper. The variance decomposition analysis indicates that all three variable are relatively exogenous variables, a high proportion of their shocks are explained by their own innovations. At the end of a 10-year period, the forecast error variance for CP explained by its own innovations is 81.6% and 73.8% for OD and 76.4% for RD respectively. Interestingly , at the end of 10 years a little for the forecast error for OD and RD is explained by CP, while RD and OD explain a bit more in the forecast of the other variables.

7) conclusion and discussion

In this paper, we focused on three pairs of relationships, between City Performance, Resource Distribution and Organizational Diversity. In this context we applied sophisticated econometric Granger causality and cointegration techniques to estimate both the causality and the direction of potential linkages. The results are surprising, in the way that we find a negative long term equilibrium between CP and OD and RD and hardly any short term relationships. Also the variance decomposition indicates high explanatory value to each variables own innovation shocks. This might be explained by the way we measured diversity (only private organizations and at a very low level of subsectors), but could also be explained by the composition of sectors in the chosen case study. Zwolle has a large focus on service oriented sectors, and although on our level of aggregation this might be very diverse at higher levels of aggregation the diversity of organizations might be less. We plan to investigate the same issue in the same period in other cities as well and compare those results to these, that might enlighten these results. Also further elaborations are to be taken into consideration concerning the model. First we want also to apply Zivot-Andrews (1992) unit root test, which allows for one structural break in the time series. When the null hypothesis of non-stationarity is not rejected by these two tests (ADF and Z-A) then proceed with the cointegration tests. Furthermore, if we do so, we should also do a Chow breakpoint test to confirm any significance for the breaks. Furthermore we can re-model the variables, where we take GDP as weakly exogenous to the system and see if that has any consequences for the results. Furthermore, we plan to do the same test with other control variables and squares of the variables to test for non-linear relationships as well.

Figure 1: variables

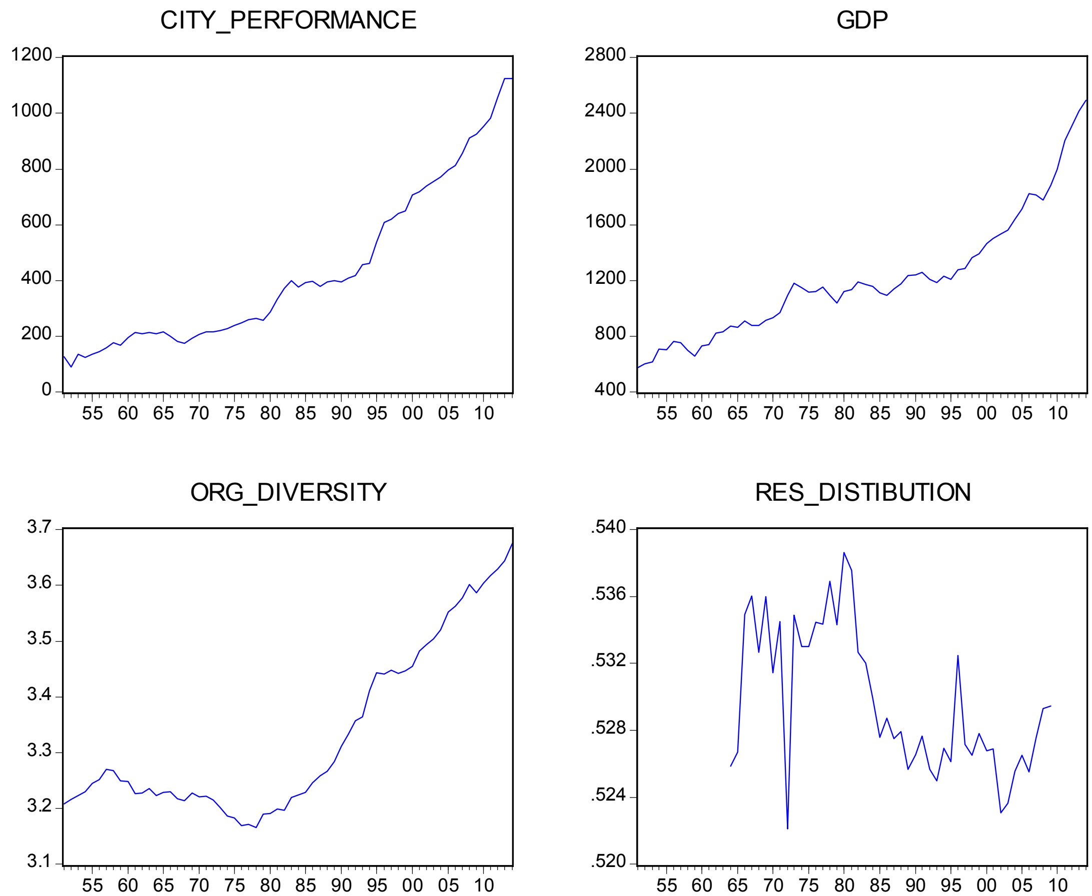

Table 1: Augmented Dickey-Fuller unit root test outcomes

		trend	constant	# lags	ADF	p-value
CP	Level	no	yes	9	3.7213	0.0006
	1 difference	no	yes	0	-6.3946	0.0000
	Level	yes	yes	9	0.7235	0.4734
	1 difference	yes	yes	8	-4.4950	0.0001
	Level	no	no	9	4.1522	0.0001
	1 difference	no	no	6	-0.4698	0.6406
RD	Level	no	Yes	0	-3.2863	0.0020
	1 difference	no	Yes	0	-10.9593	0.0000
	Level	yes	Yes	0	-4.6089	0.0000
	1 difference	yes	Yes	0	-10.8597	0.0000
	Level	no	No	1	0.1819	0.8566
	1 difference	no	no	0	-11.0821	0.0000
OD	Level	No	Yes	1	2.15544	0.0352
	1 difference	No	Yes	2	-2.21551	0.0308
	Level	Yes	Yes	0	-0.14413	0.8859
	1 difference	Yes	Yes	0	-6.40895	0.0000
	Level	No	No	3	1.5370	0.1299
	1 difference	no	no	2	-1.65063	0.1043
GDP	Level	No	Yes	3	3.07008	0.0033
	1 difference	No	Yes	0	-5.43801	0.0000
	Level	Yes	Yes	3	1.682245	0.0983

	1 difference	Yes	Yes	0	-5.98576	0.0000
	Level	No	No	1	3.458471	0.0010
	1 difference	No	no	6	0.40458	0.6879

Critical values (1% level) of the ADF statistics are approximately equal to -4.13 (trend and constant), -3.56 (constant), and -2.61 (no trend no constant)
Critical values (5% level) of the ADF statistics are approximately equal to -3.50 (trend and constant), -2.92 (constant), and -1,95 (no trend no constant)

H_0 = variable has a unit root
For CP is H0 = CP has a unit root, not rejected at level, but rejected at first difference at the 1% level for trend, trend and constant and none.
For RD is H0 = RD has a unit root, rejected for the level with a constand and a trend at the 1% level and rejected for the one with a trend at the 10% level. For the first difference H0 is rejected at the 1% level for trend, constand and trend and none
For OD is H0 = OD has a unit root, not rejected at the level and for the first difference only rejected for the trend and constant.
For GDP is H0 = GDP has a unit root, not rejected at the level, but rejected at the first difference for constant and constant and trend.
We find that all our series can be treated as *I*(1)

Notes:
(1) *RD, OD* and *CP* denote resource distribution, organizational diversity and city performance, respectively.
(2) * are significant at the 5%. Aikaike criterion critical values

Table 2: Johansen's cointegration tests (with two lags, GDP is included as an exogenous variable).

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.377710	30.75584	29.79707	0.0387
At most 1	0.189353	9.884466	15.49471	0.2897
At most 2	0.014617	0.647880	3.841466	0.4209

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.377710	20.87137	21.13162	0.0543
At most 1	0.189353	9.236586	14.26460	0.2670
At most 2	0.014617	0.647880	3.841466	0.4209

1 Cointegrating Equation(s): Log likelihood 136.1480

Normalized cointegrating coefficients (standard error in parentheses)

CP	OD	RD	c
1.000000	-2382.469	-68710.20	43873.71
	(764.733)	(14800.8)	

Table 3: Weak exogeneity test (VECM)

	χ^2	p-value
ΔCP weakly exogenous to the system	7.706820	0.0212*
ΔOD weakly exogenous to the system	1.376623	0.5024
ΔRD weakly exogenous to the system	0.506680	0.7762

Table 4. VECM Granger-causality test

Dependent variable	Wald test statistics (χ^2)		
	ΔCP	*ΔOD*	*ΔRD*
ΔCP		5.805518*	2.782798
ΔOD	0.520104		0.973242
ΔRD	0.122679	0.415245	

Note: * is significant at the 5%-level.

Table 5: variance decomposition:

Variance Decomposition of CP:

Period	S.E.	CP	OD	RD
1	19.06207	100.0000	0.000000	0.000000
2	30.56959	92.69133	6.487618	0.821051
3	40.80743	88.04099	8.925922	3.033084
4	49.44250	85.87096	10.12909	3.999945
5	57.04948	84.39435	10.78677	4.818879
6	63.83978	83.44206	11.16352	5.394413
7	70.02028	82.75871	11.39946	5.841832
8	75.71880	82.25339	11.55519	6.191421
9	81.02939	81.86428	11.66403	6.471688
10	86.01945	81.55647	11.74363	6.699902

Variance Decomposition of OD:

Period	S.E.	CP	OD	RD
1	0.013242	2.366411	97.63359	0.000000
2	0.021313	3.747620	93.16819	3.084188
3	0.028863	3.661147	88.35550	7.983357
4	0.035726	3.397939	84.70728	11.89478
5	0.042051	3.123699	81.67391	15.20239
6	0.047890	2.889612	79.29843	17.81196
7	0.053309	2.699257	77.41644	19.88431
8	0.058362	2.546379	75.92324	21.53038
9	0.063095	2.423375	74.72671	22.84992
10	0.067551	2.323635	73.75794	23.91842

Variance Decomposition of RD:

Period	S.E.	CP	OD	RD
1	0.003358	3.193425	5.604341	91.20223
2	0.003609	3.991339	9.627031	86.38163
3	0.003912	4.220239	10.84539	84.93437
4	0.004087	4.514774	12.38386	83.10136
5	0.004231	4.735659	13.53693	81.72741
6	0.004349	4.939368	14.59625	80.46439
7	0.004453	5.122088	15.54293	79.33498
8	0.004548	5.290311	16.41239	78.29730
9	0.004636	5.446006	17.21582	77.33818
10	0.004720	5.591044	17.96348	76.44548

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