The Economics of Corporate Trade Credit in Europe

Julia Koralun-Bereźnicka and
Dawid Szramowski

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Chapter 5

The relative importance of selected factors affecting corporate trade credit policy

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5 The relative importance of selected factors affecting corporate trade credit policy

5.1 Country versus industry effect in corporate trade credit behaviour

This section provides an interpretation of the cluster analysis results of binominal objects in the form of industries in countries, which was performed:

- for all size groups in total;
- in every size group separately.

To compare the relative importance of the country versus industry effect on trade credit behaviour, the *k*-means clustering technique was first applied for grouping country–industry items into three size groups of firms (small, medium, and large) as a total. The variables were averaged first for the whole period and then across all size groups. As a result, the total number of items grouped was 27, as there are three sections for each country. The number of clusters was established at the level of nine, which corresponds to the number of countries. In this way, if the country effect completely prevailed over the industry-specific features, each of the nine clusters would consist of items solely from one country, but from three different industrial sections. As this seems a very unlikely situation, a mixture of industries and countries is expected rather than single-featured groups, which in turn poses the problem of identifying the character of each cluster. To define each cluster as an industry-oriented, country-oriented, or of indefinite character, the set of rules shown in Table 5.1 was used.

As the simple rule based on comparing the number of different industry items with different country items was not sufficient for all cases, it was necessary to supplement it with another condition referring to the largest possible number of different industrial sections within one cluster, i.e. three. In a situation where a cluster comprised items representing all industrial sections, even a larger number of different country items was not treated as a premise for classifying the cluster as an industry-dominated one, as – despite the theoretical prevalence of industry features – such a cluster represents the whole variety of industries available in the database. Therefore, in such a case, the nature of the cluster was identified as nondescript.

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Table 5.1 The algorithm for identifying the character of clusters as industry or country-dominated

Condition regarding cluster composition	*Cluster character*
nº different country items = nº different industry items	N – nondescript
(nº different industry items = 3*) and (nº different country items ≥ 3)	N – nondescript
nº different country items > nº different industry items	I – industry
nº different country items < nº different industry items	C – country

Note: *– as the maximum number of different industries in each cluster is 3, even a larger number of different countries should not predetermine the cluster character as industry-oriented.

The *k*-means grouping procedure was performed for various sets of variables, i.e. first for all variables without DSO_{a1}, DPO_{a1}, and TCB_{a1}. The exclusion of these three variables is due to the fact that the sum of all the variables indexed with *a* is 100%. Including all of them as the basis for grouping would mean that one of the variables did not portray any new information. Second, the grouping was held only for the three weighted mean variables indexed with *WM*, i.e. DSO_{WM}, DPO_{WM}, and TCB_{WM}. Finally, the objects were grouped only according to the variables describing receivables management (without DSO_{a1}), payables management (without DPO_{a1}), and trade credit balance (without TCB_{a1}) to verify whether the presence of the examined effects was stable across the analytical areas. Table 5.2. shows the *k*-means grouping results into nine clusters.

Analysing the content of clusters comprising country–industry items reveals the clear predominance of the industry-specific features over the country characteristics. Regardless of the set of variables taken as the basis for classification, the number of industry-oriented clusters is always considerably larger than the number of country-based clusters. Moreover, in the case of two grouping results (based on the general set of variables and the three main weighted means) the industry-featured clusters constitute the majority of all clusters, which means that their number exceeds the number of both country clusters and the non-defined ones. The prevalence of the industry features is less evident, although still observable, in the case of receivables management, where only three clusters out of nine proved industry-oriented. However, even in this case, the number of country-dominated clusters remains in the minority. In fact, in all grouping variations for all size groups in total, there is only one country-oriented cluster, while the country responsible for its formation is in each case Germany. This can be partly attributed to the methodological differences concerning German data, for which the customer prepayments were not deducted from trade receivables in DSO and TCB ratios.

The superiority of the industrial specifics of firms over their geographical location in corporate trade credit behaviour might not necessarily be homogeneous across all size groups of companies. Therefore, it is purposeful to perform a similar grouping procedure separately in each size group. Results of these classifications are not reported here in detail, although the summarising conclusions are

Table 5.2 *K*-means grouping results of country–industry items into nine clusters

Variables involved	*Cluster number and content*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
General (all but DSO_{a1}, DPO_{a1}, TCB_{a1})	HR_CST	HR_TRD PT_TRD TR_MNF TR_TRD	BE_CST ES_CST IT_TRD	BE_TRD ES_TRD FR_TRD PL_MNF PL_TRD	BE_MNF ES_MNF FR_MNF FR_CST PL_CST	HR_MNF IT_MNF PT_MNF	DE_MNF DE_CST DE_TRD	PT_CST TR_CST	IT_CST
Main weighted means (DSO_{WM}, DPO_{WM}, TCB_{WM})	BE_CST HR_TRD IT_TRD PL_CST	FR_CST HR_CST IT_MNF PT_CST	ES_MNF FR_MNF HR_MNF PT_MNF TR_MNF	BE_MNF PL_MNF PT_TRD TR_CST	BE_TRD TR_TRD	ES_TRD FR_TRD PL_TRD	DE_CST	DE_MNF DE_TRD	ES_CST IT_CST
Receivables ($DSO_{a2–a6}$, $DSO_{b1–b7}$, DSO_{WM})	BE_CST FR_CST	TR_CST	ES_MNF HR_TRD PT_TRD TR_MNF TR_TRD	ES_CST HR_MNF HR_CST IT_MNF IT_TRD PT_MNF	BE_MNF BE_TRD ES_TRD FR_MNF PL_CST	IT_CST PT_CST	FR_TRD PL_MNF PL_TRD	DE_MNF DE_CST	DE_TRD
Payables ($DPO_{a2–a6}$, $DPO_{b1–b7}$, DPO_{WM})	BE_MNF ES_MNF FR_MNF FR_CST PL_CST	HR_CST IT_CST	BE_CST ES_CST IT_MNF IT_TRD PT_MNF	TR_CST	HR_TRD PT_TRD TR_MNF TR_TRD	BE_TRD ES_TRD FR_TRD PL_MNF PL_TRD	HR_MNF PT_CST	DE_MNF DE_CST	DE_TRD
Trade credit balance ($TCB_{a2–a6}$, $TCB_{b1–b7}$, TCB_{WM})	PT_CST TR_CST	BE_MNF BE_TRD ES_TRD PL_MNF PL_CST	BE_CST HR_CST	ES_CST HR_MNF HR_TRD IT_TRD PT_TRD TR_MNF TR_TRD	IT_MNF PT_MNF	DE_MNF DE_CST DE_TRD	FR_TRD PL_TRD	ES_MNF FR_MNF FR_CST	IT_CST

Source: authors' calculations based on ECCBSO (2020) trade credit database.

fully stated. A synthetic summary of the clustering results for each size class is shown in Table 5.3, where it is also indicated which of the two effects (country or industry) is dominant for a given set of variables.

It appears that when considering the relevant importance of the two effects by size classes several complementary findings occur. When the *k*-means grouping was performed on micro firms only, it was the country effect that prevailed over the industry effect, as indicated by the larger number of country-oriented clusters for most sets of variables. The exceptions pertain to the receivables management, for which the number of industry- and country-based clusters are equal, as well as the area of trade credit balance where the number of industry-dominated clusters is bigger than the country-dominated ones. In the remaining size groups, the prevalence of industry features in clusters again becomes a general rule. However, the proportion of industrial clusters is quite different for small firms than for medium and large ones.

Generally, it can be concluded that the industrial specifics of companies matter more for their behaviour in the area of trade credit than the country features. However, this applies to small-, medium-, and large-sized firms of the analysed group of countries, and not to the micro firms, for which the country specifics are still more important than the sectoral conditions. Moreover, the prevalence of industrial characteristics seems to grow along with firm size. Intuitively, the relation between firm size and the intensity of country impact on trade credit performance can be attributed to the fact that the operations of large firms are not always limited to the local or national markets, but quite often are implemented at

Table 5.3 The number of clusters of country–industry items according to their character

Set of variables involved	*Cluster character*	*Size group*				
		SML	*MIC*	*S*	*M*	*L*
General (all but DSO_{a1}, DPO_{a1}, TCB_{a1})	Country	1	4	3	1	1
	Industry	6	3	4	6	6
	Nondescript	2	2	2	2	2
Main weighted means (DSO_{WM}, DPO_{WM}, TCB_{WM})	Country	1	4	1	1	1
	Industry	6	2	2	5	5
	Nondescript	2	3	6	3	3
Receivables ($DSO_{a2–a6}$, $DSO_{b1–b7}$, DSO_{WM})	Country	1	2	1	1	2
	Industry	3	2	3	6	5
	Nondescript	5	5	5	2	2
Payables ($DPO_{a2–a6}$, $DPO_{b1–b7}$, DPO_{WM})	Country	1	6	1	1	2
	Industry	4	1	1	3	4
	Nondescript	4	2	7	5	3
Trade credit balance ($TCB_{a2–a6}$, $TCB_{b1–b7}$, TCB_{WM})	Country	1	2	1	0	0
	Industry	4	3	2	6	5
	Nondescript	4	4	6	3	4

Source: authors' calculations based on ECCBSO (2020) trade credit database.

Note: the higher number of clusters from the two defined as country- or industry-dominated was shaded.

the sub-regional level and therefore have a global dimension. For this reason, such firms may be less prone to regional or country specifics than, e.g. micro firms, whose activity is more likely to be closely related to local markets, and therefore expected to remain under greater influence of country-specific conditions. In other words, this might not necessarily be only the firm size as such, which is responsible for the way a firm's trade credit policy is affected by a mixture of country and industry characteristics. However, as the firm size is often correlated with the scale of activity and its global aspect, firm size may roughly serve as a proxy for internationality and the susceptibility to national influences.

5.2 Country versus size effect in corporate trade credit behaviours

This section discusses the cluster analysis results of country-size items, which was carried out:

- for all industrial sections in total,
- in every industry separately.

The evaluation of the relative importance of country versus firm size effect in corporate trade credit policy was based on the *k*-means grouping results of country-size items. Similarly to the procedure employed in the previous section, the clustering was first applied to all industrial sections as a total and was then carried out separately for each sector. The analysis was performed with the use of means of ratios, whose values were averaged first across time and then across industries. In the case of grouping country–industry items, the total number of items subject to clustering was 36, which corresponds to the four size classes of firms per each country.

The number of clusters was established at the level of nine – following the number of countries. Consequently, in the case of the absolute prevalence of the country effect over firm size characteristics, each of the nine clusters would comprise items from only one country, but of four different size groups. Certainly, a mixture of countries and sizes in each cluster is more likely to occur. Therefore, to define the nature of each cluster as a country-dominated, size-oriented, or nondescript one, a set of rules was established for this purpose. The algorithm is collated in Table 5.4.

As the simplest rule, based on comparing the number of different country items with different size items, was not satisfactory for all cases, the basic algorithm was supplemented with a condition referring to the largest possible number of different size classes within one cluster, i.e. four. In a situation, where a cluster comprised items representing all size groups, even a larger number of different country items was not considered as a reason for identifying the cluster as a size-oriented one, as – despite the theoretical prevalence of firm size features – such a cluster represents the whole variety of sizes available in the database. As a result, the character of such clusters was identified as nondescript.

Table 5.4 The algorithm for identifying the character of clusters as country- or size-dominated

Condition regarding cluster composition	*Cluster character*
nº different country items = nº different size items	N – nondescript
(nº different size items = 4*) and (nº different country items ≥ 4)	N – nondescript
nº different country items > nº different size items	S – size
nº different country items < nº different size items	C – country

Note: *– as the maximum number of different size classes in each cluster is 4, even a larger number of different countries should not predetermine the cluster character as size-oriented.

The *k*-means grouping method was applied for the same sets of variables as in the case of grouping country–industry items, i.e. first with the use of all variables without DSO_{a1}, DPO_{a1}, and TCB_{a1}, then only with the three weighted mean variables (DSO_{WM}, DPO_{WM}, and TCB_{WM}), and finally, with the variables characterising receivables management, payables management, and trade credit balance (without DSO_{a1}, DPO_{a1}, and TCB_{a1}, respectively). This was meant to see whether the prevalence of a given effect refers to the whole policy of trade credit or some specific areas only. The *k*-means grouping results of country-size items into nine clusters are collated in Table 5.5.

The structure of clusters based on the widest range of variables and for all industries as the total does not provide a straightforward answer to the question concerning the importance of the compared effects. Both country and industry features are equally observable, as indicated by the same number of country-dominated and size-dominated clusters. Similar coexistence of the two effects appears when the area of payables management is taken into account, although both effects are less pronounced here, as the majority of clusters have an undefined character. When the range of variables is limited to the three weighted mean ratios or the trade credit balance ratios, the predominance of size features is noticeable, although very slight in the case of three *WM* ratios.

Given the ambiguous indications on the relative importance of the country versus size effect, it seems purposeful to further analyse the issue across individual industries. A summary of the clustering results for each sector is shown in Table 5.6, where it is also indicated which of the two effects (country or size) prevails for a given set of variables.

It appears that when analysing the structure of clusters by industries, their nature is much clearer, although quite dissimilar. Regardless of the range of variables included in the analysis, the country effect prevailed over the size effect in the construction section. This dominance was not overwhelming, though, as in each version of clustering the number of undefined clusters was considerable, and the difference between the number of country-dominated clusters and size-dominated ones was not larger than two. The opposite situation can be observed in the other two sectors, i.e. manufacturing and trade, where the country features are less marked than the size characteristics. An interesting feature concerns the area

Table 5.5 *K*-means grouping results of country-size items into nine clusters

Variables involved	*Cluster number and content*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
General (all but DSO_{a1}, DPO_{a1}, TCB_{a1})	BE_MIC IT_MIC PT_MIC TR_MIC	ES_MIC HR_S PL_MIC	HR_M IT_L PT_S PT_M TR_S	BE_S ES_S ES_M ES_L HR_L PT_L TR_M TR_L	IT_S IT_M	BE_M FR_MIC FR_S FR_M FR_L	BE_L DE_MIC PL_S PL_M PL_L	DE_S DE_M DE_L	HR_MIC
Main weighted means (DSO_{WM}, DPO_{WM}, TCB_{WM})	BE_L DE_MIC ES_L FR_L PL_S PL_M PL_L PT_L TR_L	ES_MIC PL_MIC	BE_S BE_M FR_MIC FR_S FR_M HR_L TR_S	HR_M PT_S PT_M	DE_S DE_M DE_L	ES_S ES_M TR_M	HR_S IT_L TR_MIC	BE_MIC IT_S IT_M PT_MIC	HR_MIC IT_MIC
Receivables ($DSO_{a2–a6}$, $DSO_{b1–b7}$, DSO_{WM})	BE_S ES_S ES_L HR_L PL_MIC PT_L TR_M TR_L	IT_L PT_S	ES_M HR_S HR_M PT_M	ES_MIC TR_S	BE_M BE_L FR_MIC FR_S FR_M FR_L PL_S PL_M PL_L	DE_MIC DE_S DE_M DE_L	IT_S IT_M	BE_MIC IT_MIC PT_MIC TR_MIC	HR_MIC

(*Continued*)

Table 5.5 (Continued)

Variables involved	*Cluster number and content*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Payables (DPO_{a2-a6}, DPO_{b1-b7}, DPO_{WM})	ES_MIC HR_S PL_MIC	IT_S IT_M IT_L	BE_S DE_MIC ES_L HR_M HR_L PT_S PT_M TR_S	BE_MIC IT_MIC PT_MIC TR_MIC	ES_M PL_S TR_M TR_L	BE_M ES_S FR_MIC FR_S FR_M FR_L PT_L	BE_L DE_S PL_M PL_L	DE_M DE_L	HR_MIC
Trade credit balance (TCB_{a2-a6}, TCB_{b1-b7}, TCB_{WM})	HR_S IT_S PL_MIC TR_S	ES_MIC PT_MIC	ES_M HR_M IT_M PT_S PT_M TR_M	BE_S ES_S ES_L HR_L IT_L PT_L TR_L	FR_MIC FR_S FR_M	BE_M PL_S	BE_L DE_MIC FR_L PL_M PL_L	DE_S DE_M DE_L	BE_MIC HR_MIC IT_MIC TR_MIC

Source: authors' calculations based on ECCBSO (2020) trade credit database.

Table 5.6 The number of clusters of country-size items according to their character

Set of variables involved	*Cluster character*	*Industry*			
		All	*MNF*	*CST*	*TRD*
General (all but DSO_{a1}, DPO_{a1}, TCB_{a1})	Country	4	2	4	1
	Size	4	3	2	6
	Nondescript	1	4	3	2
Main weighted means (DSO_{WM}, DPO_{WM}, TCB_{WM})	Country	1	1	2	1
	Size	2	4	1	6
	Nondescript	6	4	6	2
Receivables ($DSO_{a2–a6}$, $DSO_{b1–b7}$, DSO_{WM})	Country	3	3	3	4
	Size	2	1	2	2
	Nondescript	4	5	4	3
Payables ($DPO_{a2–a6}$, $DPO_{b1–b7}$, DPO_{WM})	Country	2	3	4	2
	Size	2	5	2	4
	Nondescript	5	1	3	3
Trade credit balance ($TCB_{a2–a6}$, $TCB_{b1–b7}$, TCB_{WM})	Country	2	1	4	2
	Size	6	6	3	4
	Nondescript	1	2	2	3

Source: authors' calculations based on ECCBSO (2020) trade credit database.

Note: the higher number of clusters from the two defined as country- or size-dominated was shaded.

of receivables management: regardless of the industrial classification, country-oriented clusters outnumber those dominated by size items.

In the case of undefined clusters, which constitute a mixture of various sizes and countries, it is clear that there are some important common features other than those related to size and country which make the clustered items similar. However, it might be informative to take a closer look at the structure of clusters that are country-oriented and size-oriented, especially in the case of those clusters, where there is just one leader in the form of a country or size. In the first case, it is again often Germany which constitutes a separate group of all-sized items, whereas in the other case, size-dominated clusters are most often stemmed around micro firms. A repetitive pattern is formed by Croatian micro firms, which usually create a one-element cluster.

The identified regularities concerning the relative importance of the size and country effect depending on the industrial classification of firms can be intuitively explained as follows. The dominance of the country effect over the size effect in the construction sector indicates that companies operating within this section might be more likely to be affected by local factors because the specificity of construction firms often ties their activities to certain regions or narrower geographical locations. This makes them more prone to domestic-related factors than, for example, trade companies or manufacturing firms. The activity of firms operating in the latter two sectors seems less tied to a certain location or market and therefore makes them less susceptible to country-specific influences. As a result, other

than country factors, such as, e.g. firm size, tend to prevail when it comes to making decisions concerning working capital management.

5.3 Industry versus size effect in corporate trade credit behaviour

This section provides the interpretation of the cluster analysis results of binominal objects in the form of industries in size groups, which was performed:

- for all size countries in total;
- in every country separately.

To evaluate the relative importance of industry versus firm size effect in corporate trade credit behaviour, cluster analysis was again used as an indication. This time an analogous procedure of *k*-means grouping was carried out on the objects constituting size classes in industries, which can therefore be simply called industry-size items. As in previous sections, the grouping technique was employed first for all countries in total and then followed by separate analyses for individual countries. Means of ratios were used as the values of variables, i.e. the ratios were first averaged across time and then across countries. The total number of industry-size items subject to cluster analysis equals 12, as there are four size groups of firms in each of the three sectors analysed. The declared number of clusters to be formed by the industry-size objects was established at the level of four, which corresponds to the number of the distinguished size classes. As a result, in the purely theoretical case of complete dominance of the firm size effect over the industry effect, each cluster would consist of items representing only one size group, but all three industrial sections. As the empirical grouping results are likely to be more ambiguous, it is purposeful to establish an algorithm enabling the definition of each cluster's character. The set of rules making up this algorithm is presented in Table 5.7.

The intuitive rule based on a simple comparison of the number of different industry items with the number of different size items was not sufficient for all cases. Therefore, the basic algorithm was supplemented with a condition referring to the largest possible number of different industrial sections within one cluster,

Table 5.7 The algorithm for identifying the character of clusters as industry- or size-dominated

Condition regarding cluster composition	*Cluster character*
nº different industry items = nº different size items	N – nondescript
(nº different industry items = 3) and (nº different size items ≥ 3*)	N – nondescript
nº different industry items > nº different size items	S – size
nº different industry items < nº different size items	I – industry

Note: *- as the maximum number of different industrial sections in each cluster is 3, even a larger number of different size classes should not predetermine the cluster character as industry-oriented.

i.e. three. In a situation where a cluster comprised items representing all sectors, even a larger number of different size items could not be considered as a reason for identifying the cluster as an industry-dominated one, as – despite the advantage of industrial features – such a cluster would represent the whole cross-section of industries covered by the analysis. Consequently, in such situations, the clusters were defined as nondescript.

The *k*-means clustering was performed for the same sets of variables as in the case of two previous grouping procedures (grouping of country–industry items and grouping of country-size items), i.e. first for all variables without DSO_{a1}, DPO_{a1}, and TCB_{a1}, then for the three weighted mean variables, and finally for the variables characterising receivables, payables, and trade credit balance (without DSO_{a1}, DPO_{a1}, and TCB_{a1}, respectively). Such variations were aimed at revealing whether the dominance of a given effect is particularly evident for some specific area of trade credit policy. The *k*-means grouping results of industry-size items into four clusters or all countries in total can be traced in Table 5.8.

The clustering results for the whole population of countries based on the largest set of ratios indicate the greater importance of the industry effect. Three of the created clusters correspond almost ideally to the three industries, whereas one cluster is a size-oriented one, comprising elements from all industries, but only representing one size, namely micro firms. Similar conclusions can be drawn from

Table 5.8 *K*-means grouping results of industry-size items into four clusters

Variables involved	*Cluster number and content*			
	1	*2*	*3*	*4*
General (all but DSO_{a1}, DPO_{a1}, TCB_{a1})	CST_S CST_M CST_L	MNF_S MNF_M	MNF_L TRD_S TRD_M TRD_L	MNF_MIC CST_MIC TRD_MIC
Main weighted means (DSO_{WM}, DPO_{WM}, TCB_{WM})	CST_S TRD_MIC	MNF_L TRD_S TRD_M TRD_L	MNF_MIC CST_MIC CST_M CST_L	MNF_S MNF_M
Receivables ($DSO_{a2–a6}$, $DSO_{b1–b7}$, DSO_{WM})	MNF_S MNF_M MNF_L	CST_S CST_M CST_L	MNF_MIC CST_MIC TRD_MIC	TRD_S TRD_M TRD_L
Payables ($DPO_{a2–a6}$, $DPO_{b1–b7}$, DPO_{WM})	MNF_S CST_S CST_M	CST_L	MNF_M MNF_L TRD_S TRD_M TRD_L	MNF_MIC CST_MIC TRD_MIC
Trade credit balance ($TCB_{a2–a6}$, $TCB_{b1–b7}$, TCB_{WM})	CST_MIC	MNF_MIC CST_S CST_M CST_L TRD_MIC	TRD_S TRD_M TRD_L	MNF_S MNF_M MNF_L

Source: authors' calculations based on ECCBSO (2020) trade credit database.

the grouping procedures performed for other sets of variables, except for ratios characterising payables management, where the dominant effect cannot be identified based on the clustering results, as there is only one industry-oriented and one size-oriented cluster, while the remaining two are nondescript.

Despite the prevalence of the industry effect over the size effect in all countries treated as a total, it is necessary to verify whether this dominance is characteristic for all countries considered individually. Table 5.9 shows a synthetic summary of the clustering analysis results across countries, along with the indication of the dominant effect.

The by-country analysis of clustering results reveals that the prevalence of the industry effect over the size effect is evident only in three countries, i.e. in Spain, France, and Italy. Belgium, in turn, is the only country for which the size effect was more relevant than industrial features of companies. In the remaining countries, it was difficult or impossible to identify the dominant effect, at least based on the clustering results.

As for the analytical areas, it can be noticed that the dominance of the industrial features over the size-related ones was much clearer for receivables management, as well as for the variables characterising trade credit balance, whereas the area of payables management was more dependent on the size effect.

It is worth identifying which items in terms of sectors or size classes are most characteristic and therefore most often responsible for forming clusters with only one leading item in the form of an industry or a size. A closer analysis of the structure of the single-industry clusters leads to the conclusion that the most frequent industry-oriented clusters are those formed by construction companies of various

Table 5.9 The number of clusters of industry-size items according to their character

Variables involved	*Cluster character*	*Country*									
		All	*BE*	*DE*	*ES*	*FR*	*HR*	*IT*	*PL*	*PT*	*TR*
General (all but DSO_{a1}, DPO_{a1}, TCB_{a1})	Industry	3	1	0	2	3	1	2	1	1	0
	Size	1	2	2	1	0	1	0	2	1	1
	Nondescript	0	1	2	1	1	2	2	1	2	3
Main weighted means (DSO_{WM}, DPO_{WM}, TCB_{WM})	Industry	3	1	1	2	3	0	3	3	1	1
	Size	0	2	1	0	0	3	0	0	2	2
	Nondescript	1	1	2	2	1	1	1	1	1	1
Receivables ($DSO_{a2–a6}$, $DSO_{b1–b7}$, DSO_{WM})	Industry	3	1	2	3	3	1	4	3	2	2
	Size	1	2	1	0	0	1	0	0	0	1
	Nondescript	0	1	1	1	1	2	0	1	2	1
Payables ($DPO_{a2–a6}$, $DPO_{b1–b7}$, DPO_{WM})	Industry	1	1	0	2	3	1	2	1	1	0
	Size	1	2	2	0	0	1	0	2	1	1
	Nondescript	2	1	2	2	1	2	2	1	2	3
Trade credit balance ($TCB_{a2–a6}$, $TCB_{b1–b7}$, TCB_{WM})	Industry	3	1	3	3	4	2	2	2	3	0
	Size	0	1	0	0	0	1	0	1	0	1
	Nondescript	1	2	1	1	0	1	2	1	1	3

Source: authors' calculations based on ECCBSO (2020) trade credit database.

Note: the higher number of clusters from the two defined as the industry- or size-dominated was shaded.

sizes. It must be borne in mind, however, that the number of single-industry clusters created by the other two sectors, i.e. trade and manufacturing, is not strikingly lower. The share of the three sectors in creating single-industry clusters is roughly comparable, as opposed to the situation in terms of single-sized clusters of industry-size items. In this case, micro firms are the most outstanding and therefore most likely to cluster together regardless of their industrial characteristics. The occasional one-item clusters are commonly formed by micro construction firms.

To summarise the relevant importance of the industry and size effect on corporate trade credit behaviours, the main regularities identified include the prevalence of industrial features with a fairly comparable intensity of the three sectors covered by the analysis. Apart from the lower mattering of the size-related firm characteristics for trade credit policy, it appears that the existence of the size effect is attributable mainly to micro firms. As indicated in Section 3.3, micro firms are characterised by receivables and payables cycles considerably longer than small firms and even more different than medium and large companies. The gap between micro firms and their larger peers in terms of trade credit behaviour confirms the need and purposefulness of distinguishing the smallest companies in the size-based classification.

5.4 Similarity evaluation of clustering results

Apart from knowing how alike individual countries, size groups, and industries are in terms of corporate trade credit policies, it might be informative to find out how similar or different the binominal items within each of these categories are clustered. This in turn will produce deeper insights into the multi-layered regularities concerning the analysed issues.

Therefore, this section provides information on the similarity (or dissimilarity) of the grouping results presented earlier in this chapter. For this purpose, the adjusted Rand's similarity index was calculated to compare the following partitions:

- the grouping results of industries in countries industries across size groups;
- the grouping results of size groups in countries industries across industries;
- the grouping results of size groups in industries across countries.

The following figure provides a graphical illustration of the earlier discussed differences between the size groups of firms. The tree diagram in Figure 5.1 is based on three main weighted mean variables (DSO_{WM}, DPO_{WM}, and TCB_{WM}) averaged for all countries, industries, and years.

The above tree diagram visualises and confirms the previously noticed differences between size groups of firms, where the main characteristic feature is the dissimilarity observed between micro firms and all other sized firms. The otherness of micro firms, demonstrated mainly through the longest periods of receivables and payables, as shown in Section 3.3, raises the need to verify whether the grouping results of the binominal objects across size groups follow similar

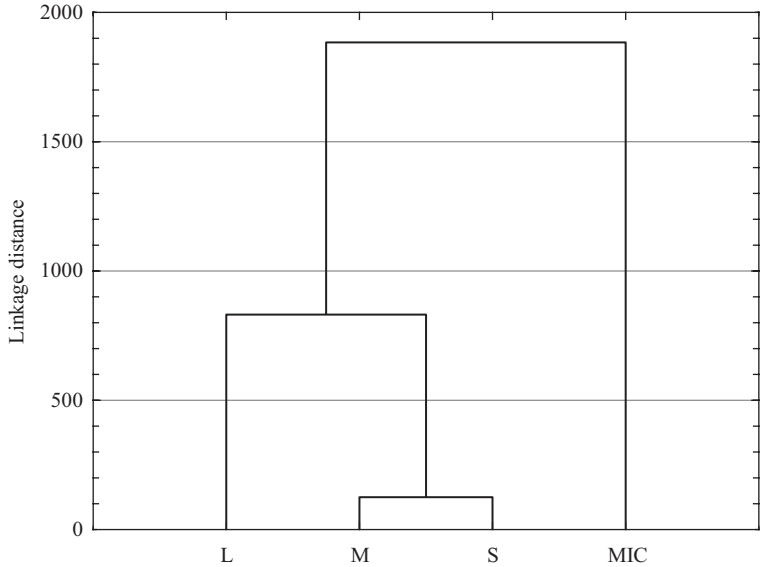

Figure 5.1 Agglomerative clustering results of size groups. Notes: the tree diagram based on three main weighted mean ratios (DSO_{WM}, DPO_{WM}, TCB_{WM}) averaged for all countries, industries, and years; Ward linking method, square Euclidean distance. Source: authors' calculations based on ECCBSO (2020) trade credit database.

Table 5.10 Comparison of clustering results across size groups: values of adjusted Rand similarity index

Size group	*MIC*	*S*	*M*
S	0.222		
M	0.096	0.276	
L	0.084	0.126	0.252

Source: authors' calculations based on ECCBSO (2020) trade credit database.

patterns. The adjusted Rand (AR) measure pairwise values for size classes calculated for assessing the similarity of clustering results of industries in countries are collated in Table 5.10.

The generally low AR values (0.176 on average) indicate little resemblance of partitions across the size groups of firms. At the same time, the low similarity confirms the importance of the size effect – revealed not only in significantly different trade credit ratios across size groups but also in the fact that the binominal objects in the form of industries in countries (of a given size class) tend to cluster quite differently than analogical items from another size class. Moreover, micro firms again tend to be the most outstanding from other size classes.

The tree diagram in Figure 5.2 indicates the apparent specificity of the construction sector, as evidenced by its dissimilarity from the manufacturing and trade sectors.

It is perhaps worth repeating that the prolonged payables cycles are the main reason behind the distinctness of the construction industry. When analysing the values of the AR measure (reported in Table 5.11) employed for comparing partitions of size groups in countries across industries, it appears again that the manufacturing and trade sectors are much closer to each other in terms of clustering results. The adjusted Rand index is roughly twice as high for the manufacturing–trade pair of sectors than for the other two pairs formed with the construction industry.

The last category of binominal items subject to the *k*-means clustering procedure performed in the previous section consisted of objects formed by a combination of industry and size. The analysis was carried out in each country, whereas the agglomerative clustering results for countries are shown in Figure 5.3.

If the tree branches were cut where the linkage distance is around 2000, three clear clusters would be identified, one of which consists of just one element, Germany. The dissimilarity of German companies in terms of trade credit can be partly attributed to the earlier-mentioned methodological differences in the calculation of some ratios. As for the resemblance of other countries, it would be interesting to know

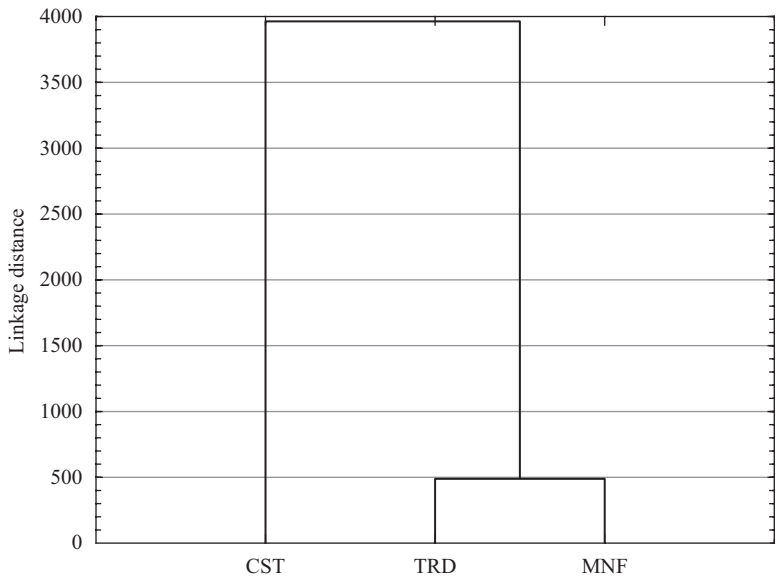

Figure 5.2 Agglomerative clustering results of industries. Notes: the tree diagram based on three main weighted mean ratios (DSO_{WM}, DPO_{WM}, TCB_{WM}) averaged for all countries, three size groups (S, M, L), and years; Ward linking method, square Euclidean distance. Source: authors' calculations based on ECCBSO (2020) trade credit database.

Table 5.11 Comparison of clustering results across industries: values of adjusted Rand similarity index

Industry	*MNF*	*CST*
CST	0.174	
TRD	0.382	0.198

Source: authors' calculations based on ECCBSO (2020) trade credit database.

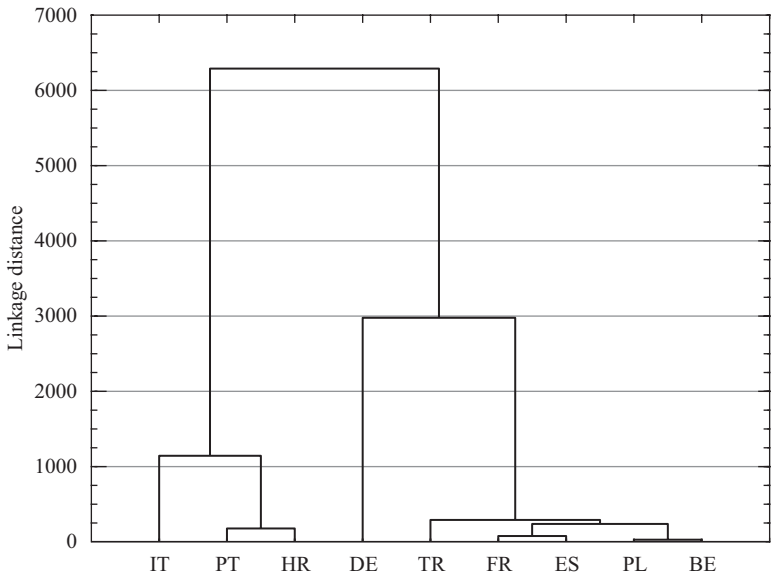

Figure 5.3 Agglomerative clustering results of countries. Notes: the tree diagram based on three main weighted mean ratios (DSO_{WM}, DPO_{WM}, TCB_{WM}) averaged for all industries, three size groups (S, M, L), and years; Ward linking method, square Euclidean distance. Source: authors' calculations based on ECCBSO (2020) trade credit database.

whether the way size groups in industries are clustered in each country corresponds to the agglomerative clustering results of countries as such. The issues may be compared by analysing the AR values calculated for comparing partitions of size groups in industries across countries, as reported in Table 5.12.

The comparison of these results leads to the conclusion that there are some significant differences between them. As for the similarity of the grouping results, the highest value was recorded for the pair of countries formed by France and Croatia. In this case, the AR index can be interpreted as evidence of moderate similarity as it exceeds the value of 0.5. Meanwhile, according to the results of the agglomerative cluster analysis carried out for the same set of variables as the

Table 5.12 Comparison of clustering results across countries: values of adjusted Rand similarity index

Country	*BE*	*DE*	*ES*	*FR*	*HR*	*IT*	*PL*	*PT*
DE	0.329							
ES	0.075	0.339						
FR	0.103	0.103	0.186					
HR	0.004	0.276	0.031	0.527				
IT	0.163	0.075	0.340	0.263	0.284			
PL	0.209	0.395	0.311	0.399	0.249	0.397		
PT	0.138	–0.054	0.075	0.266	0.185	0.163	0.116	
TR	0.425	0.329	0.075	–0.061	0.004	0.075	0.302	0.042

Source: authors' calculations based on ECCBSO (2020) trade credit database.

compared results of the *k*-means clustering, France is in a different cluster than Croatia, which in turn indicates their significant dissimilarity. The reverse is the case for the pair of countries formed by France and Turkey, which are in the same cluster on the tree chart but are characterised by high dissimilarity (AR < 0) in terms of the *k*-means grouping results of size groups in industries.

However, there are also countries for which the similarity of grouping results of size groups in industries corresponds to the similarity of the countries themselves. This is the case, for instance, for Croatia and Turkey – dissimilar in both cases, or for Turkey and Belgium – close to each other in both cases.

Summarising the above comparisons, it can be concluded that the similarity of monomial objects (countries, industries, and size groups) in terms of the basic parameters characterising corporate trade credit policy does not fully correspond to the results of the similarity evaluation of the binomial objects' classification in these categories (size groups in industries, size groups in countries, and industries in countries, respectively) based on the same set of variables. The lack of this similarity applies especially to the results of countries' agglomerative clustering and the results of the similarity analysis of size groups in industries across countries. This provides another confirmation of the occurrence of the country, industry, and size effects in the analysed cross-sections.

5.5 Contribution of variables to the classification results

The stage of hierarchisation of the trade credit factors could be followed by analysing the contribution of individual variables to the resulting classification structures. As mentioned in the methodical part of the study, the HINoV method was used for this purpose. Apart from being used as a way of eliminating redundant variables, the HINoV may also serve as a method for showing the contribution of each variable involved in the grouping process. In the case of this study, the information about this type of input may be all the more interesting as three different types of binomial objects were grouped, the final arrangement of which in clusters

could depend on individual variables to a different extent. The HINoV was applied for the classification of the following objects using the *k*-means method based on ratios averaged across time:

- industrial sections in countries;
- size groups in countries;
- size groups in industries.

On the basis of the obtained classification results, it is possible to evaluate how each of the variables involved contributes to the resulting structure. Details on the contribution of each ratio are presented in Table 5.13.

The TOPRI values ranked from the highest reveal that the contribution of variables is quite varied across the different sorts of objects. And so, when grouping objects in the form of industries in counties, it appears that the variables representing payables management weighed most according to the values of TOPRI. In the other two grouping variants, it seems that the remaining areas of trade credit were more important, with receivables management ratios contributing most to the clustering results of the size groups in countries, and with trade credit balance ratios more relevant in the case of clustering size groups in industries.

Similarly, when it comes to identifying the 'noisy' variables, i.e. those that in a way contradict the main tendencies in the majority of grouping results, it is difficult to distinguish a common set of such ratios. Although the TCB_{WM} ratio proved the least contributive in the case of grouping size classes in countries and size classes in industries, it appeared quite relevant in the case of grouping industries in countries.

A useful tool allowing for a synthetic comparison of the rank orders is the Spearman's correlation coefficient (r_s), which measures the strength and direction of the association between ranked variables:

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n\left(n^2 - 1\right)} \tag{5.1}$$

where:

d_i – difference in paired ranks;
n – number of cases.

The r_s values for the rankings presented in Table 5.13 are shown in Table 5.14.

The values of the rank-order correlation coefficient indicate low and moderate associations between the compared rankings of variables. This, in turn, provides support for the quite diverse importance of individual variables for the final clustering results.

Summing up the analysis using the HINoV method, it can be stated that it did not provide clear grounds for eliminating some of the variables. Moreover, leaving all the variables in the target set of diagnostic features, despite their unequal

Table 5.13 Contribution of variables to the *k*-means classification results based on the HINoV method

Ratio	*Items subject to grouping*					
	Industries in countries		*Size groups in countries*		*Size groups in industries*	
	Rank	*Contribution*	*Rank*	*Contribution*	*Rank*	*Contribution*
DSO_{a1}	25	2.226	20	4.239	18	6.109
DSO_{a2}	12	3.583	25	3.819	25	5.105
DSO_{a3}	39	0.731	30	3.540	26	5.001
DSO_{a4}	36	1.274	9	5.067	33	3.854
DSO_{a5}	22	2.696	16	4.420	24	5.511
DSO_{a6}	10	3.764	6	5.825	10	7.924
DSO_{b1}	29	1.839	41	0.413	2	10.529
DSO_{b2}	35	1.522	26	3.812	31	4.712
DSO_{b3}	34	1.527	35	2.566	11	7.858
DSO_{b4}	5	4.325	11	4.667	17	6.443
DSO_{b5}	11	3.611	8	5.309	5	8.554
DSO_{b6}	9	3.805	1	7.434	7	8.297
DSO_{b7}	3	4.780	2	7.374	7	8.297
DSO_{WM}	15	3.285	32	3.414	36	3.542
DPO_{a1}	42	0.043	39	1.572	38	2.564
DPO_{a2}	21	2.762	34	2.967	22	5.536
DPO_{a3}	30	1.752	24	3.824	34	3.830
DPO_{a4}	40	0.517	29	3.620	30	4.772
DPO_{a5}	7	3.983	36	2.480	39	2.494
DPO_{a6}	1	5.476	15	4.432	28	4.986
DPO_{b1}	27	1.964	10	4.894	21	5.685
DPO_{b2}	24	2.406	22	3.945	16	6.501
DPO_{b3}	20	2.810	28	3.666	22	5.536
DPO_{b4}	16	3.130	11	4.667	35	3.769
DPO_{b5}	2	5.172	23	3.940	27	4.988
DPO_{b6}	4	4.654	7	5.378	12	7.300
DPO_{b7}	26	2.127	18	4.334	12	7.300
DPO_{WM}	23	2.686	17	4.390	29	4.980
TCB_{a1}	38	0.822	38	1.597	3	9.123
TCB_{a2}	13	3.419	13	4.549	32	4.708
TCB_{a3}	31	1.709	40	1.129	19	5.939
TCB_{a4}	17	3.087	27	3.786	14	6.674
TCB_{a5}	6	3.988	33	3.283	41	2.308
TCB_{a6}	8	3.879	4	6.384	4	9.103
TCB_{b1}	19	2.871	21	4.191	6	8.298
TCB_{b2}	32	1.694	14	4.528	9	7.972
TCB_{b3}	37	1.255	31	3.414	14	6.674
TCB_{b4}	41	0.451	37	2.081	40	2.330
TCB_{b5}	28	1.841	19	4.277	37	2.745
TCB_{b6}	14	3.396	3	6.576	20	5.860
TCB_{b7}	18	3.074	5	5.912	1	11.213
TCB_{WM}	33	1.532	42	0.214	42	0.195

Source: authors' calculations based on ECCBSO (2020) trade credit database.

Table 5.14 Spearman's rank-order correlation coefficient for rankings of variables

	Industries in countries	*Size groups in countries*
Size groups in countries	0.535	
Size groups in industries	0.167	0.370

Source: authors' calculations based on ECCBSO (2020) trade credit database.

contribution, enabled comparative analysis of the clustering results of various objects. The use of different sets of variables as the basis for grouping different kinds of binomial objects would significantly complicate such cross-sectional analyses.

Reference

ECCBSO. 2020. 'Trade Credit Data Base'. https://www.eccbso.org/wba/pubblica/database.asp.