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Network and diversification in audio-visual market

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Abstract

This paper studies the effect of network on product diversification in audio-visual market. We use register data on links between companies from Discop East 2008 market, the largest audio-visual market in East-Europe. Empirical estimation of network effects has often been difficult because of the presence of three related effects: endogenous effect, exogenous effect and correlated effect. We use a methodology that allows disentangling endogenous network effects from exogenous effects after eliminating correlated effects by network transformation. We find that network of a company has a significant positive effect on the diversity of product and services it trades in the market.

1. Introduction

Diversification has a long standing in economic and managerial research. The literature has paid extensive attention to corporate diversification, emphasising the benefit from diversification in terms of lower costs and risk spreading, as would arise from exploitation of economics of scale and scope by companies. However, there has been little research on the diversification in the audio-visual market. In Europe the market generates a turnover of more than € 650 billion annually, contributes to 2.6% of EU's GDP and employs 3% of EU work force (European Union 2009). Technological advancement, in particular digitisation of a vast majority of products, has drastically reduced cost of production and transportation. This has created the opportunity for network to play an important role in product diversification of companies. The creation of the European Single Digital Market has also broadened the scope of diversification though business networks.

In this paper we study the effect of business network on product diversification in audio-visual market. The central proposition of the study is that business network exerts significant effect on product diversification. We use register data from the Discop East 2008, the largest audio-visual market in East Europe organised annually in Budapest. The data allows us to identify links between companies as they meet each in this market. Empirical study of network effect has often encountered difficulty in delineating network effects. Three related effects – endogenous network effect, exogenous network effect and correlated effect – are found to be difficult to disentangle (Manski 1993). We use a methodology developed in the domain of Behavioural Economics to study effects of social interaction in a variety of contexts. The methodology allows disentangling endogenous network effects from exogenous effect after eliminating correlated effect using a simple network transformation. Our econometrics results show that business network exerts a significant positive effect on the product diversification of a company – higher the product diversity of a company's business contacts higher is its own product diversity.

Rest of the paper is organised as follows. Section 2 presents the methodology used for the estimation of network effects. Data are presented in Section 3. Section 4 presents our econometrics results. Section 5 concludes the paper.

2. Methodology

We use a methodology developed and applied in the domain of behavioural economics. Manski (1993) distinguishes between endogenous, exogenous and correlated effects in network context. The endogenous effect implies that individual choice varies with the group behaviours. The exogenous effect refers to the influence that individual behaviour receives from the exogenous characteristics of the group. The correlated effect involves that individuals belonging to the same group take the same decision because they have similar individual characteristics and they share the same institutional framework. Two main identification problems arise in this context. First, it is difficult to distinguish real network effect (endogenous and exogenous) from correlated effects. Second, even in the absence of correlated effects, simultaneity in behaviour of interacting agents introduces a perfect collinearity between the expected mean outcome of the group and its mean characteristics. This reflection problem hinders identification of the endogenous effect from the exogenous effects.

Often a linear-in-mean model is employed to measure social network effect. The model takes the following form

$$y_i = \alpha + \beta \frac{\sum_{j \in N_i} y_j}{n_i} + \gamma x_i + \delta \frac{\sum_{j \in N_i} x_j}{n_i} + \varepsilon_i \qquad [1]$$

where y_i is the outcome of individual i, N_i is the network of i with cardinality n_i, x is a vector of characteristics. In this model, β captures the endogenous network effect and δ the exogenous network effect. It is standard to require that $|\beta| \prec 1$. Assume that $E[\varepsilon \mid x] = 0$. Hence, correlated effect is assumed away in this simple model. The endogenous effect, often called the network effect, measures the effect of outcomes of other members of an individual's network on his/her one outcome. This model is used in behavioural economics in a variety of contexts – criminal activity in Glaeser et al (1996), welfare participation in Bertrand et al. (2000), school achievement in Sacerdote (2001) and obesity in Trogdon et al. (2008).

Few data sets contain information on actual contacts. Often mean neighbourhood characteristics are used to proxy for networks. This implicitly incorporates an unlikely assumption that contacts are randomly distributed within neighbourhoods. However, estimation is still problematic even if the data on actual contacts are available. As noted above, the reflection problem appears in the way to disentangle the endogenous effect from the exogenous effect. Recently, Bramoulle et al. (2009) provide a tractable methodology using network data in order to disentangle these two effects. They provide testable conditions on network structure that are sufficient for the identification of network effects.

Suppose that G is an $n \times n$ interaction matrix with $G_{ij} = 1$ if i is linked to j and 0 otherwise. Denote an $n \times 1$ matrix by l. We can write the structural equation using matrix notation as

$$Y = \alpha l + \beta GY + \gamma X + \delta GX + \varepsilon \ , \qquad E[\varepsilon \mid X] = 0 \qquad [2]$$

Note that if G is row normalised the term GY represents mean outcome of an individual's network contacts, and the term GX represents mean characteristics of an individual's contacts.

The condition of the identification of the model parameters is developed in Bramoulle et al. (2009). They show that when I (an $n \times n$ identity matrix), G and G^2 are linearly independent network effects are identified. This condition has a natural interpretation in terms of instrumental variables. When no company is isolated, the matrices I, G and G^2 are linearly dependent if and only if $E[GY \mid X)$ is perfectly collinear with (l, X, GX). This perfect collinearity means that a valid instrument for GY in structural equation [2] can not be found. On the contrary, when $E[GY \mid X)$ is not perfectly collinear with the regressors, the restriction imposed by the network structure allows the model to be identified. The condition implies a particular structure of the network – the existence of intransitive triads. Intuitively the condition states that the characteristics of i's contacts' contacts who are not connected with i can be used as instrument for the outcomes of i's contacts. The variables $(G^2X, G^3X, ...)$ can be used as valid instruments for GY. Note that G^2X has an intuitive interpretation, when G is row normalised it represents the weighted average of characteristics of the contacts' contacts in the network. The idea resembles the identification strategy of panel data model where strictly exogenous regressors can be used to distinguish true state dependence from correlated heterogeneity (Chamberlain 1984).

In presence of correlated effect a network transformation can be used in order to identify model parameters. Bramoulle et al. (2009) show that when the assumption of no correlated effects (i.e. $E[\varepsilon \mid x] = 0$) is relaxed a local or a global transformation can applied. The idea is again similar to that of panel data model where differencing is used to eliminate fixed effects. Applying local transformation the structural model can be written as

$$(I-G)Y=\beta(I-G)GY+\gamma(I-G)X+\delta(I-G)GX+(I-G)\varepsilon \quad [3]$$

With this transformation network effects are identified when the matrices I, G, G^2 and G^3 are linearly independent. The matrices I, G, G^2 and G^3 are linearly dependent if and only if $E[(I-G)GY \mid X]$ is perfectly collinear with $((I-G),(I-G)X,(I-G)GX)$. Again, when $E[(I-G)GY \mid X]$ is not perfectly collinear with the regressors, the variables $((I-G)G^2X,(I-G)G^3X,........)$ can be used for valid instruments for $((I-G)GY)$.

The condition for identification is more complicated in presence of correlated effects. However, the condition implies that in addition to intransitivity the diameter of the network must be greater than or equal to three. The diameter restriction implies that it is possible to find i and j separated by a distance of three in the network. Intuitively, a diameter of three or more with intransitivity means that the difference between k and l can be used as instrument for the difference between i and j, where i is connected with j, j is connected with k, k is connected with l, but i is not connected with either k or l and j is not connected with l. In our application both the conditions are satisfied.

Assuming that the errors are independent, the Generalised 2SLS strategy can be applied for estimation (Kelejian and Prucha 1998; Lee 2003). Note that homoskedasticity is not assumed. In the first step $S=[(I-G)X \quad (I-G)GX \quad (I-G)G^2X]$ is used as instrument to obtain

$$\hat{\theta}_{1st-step}=(\widetilde{X}'P\widetilde{X})^{-1}\widetilde{X}'PY$$

where $\widetilde{X}=[(I-G)GY \quad (I-G)X \quad (I-G)GX]$ is the matrix of explanatory variables and $P=S(S'S)^{-1}S$ is the weighting matrix.

In the second step, $\hat{Z}=Z(\hat{\theta}_{1st-step})$ is used as instrument, with $Z=[E[(I-G)GY(\theta) \mid X,G] \quad (I-G)X \quad (I-G)GX]$.

It is easy to verify that

$$E[(I-G)GY(\theta) \mid X,G]=G(I-\beta G)^{-1}[(I-G)(X\gamma+GX\delta)]$$

Using this simplification we have

$$\hat{\theta}_{2nd-step}=(\hat{Z}'\widetilde{X})^{-1}\hat{Z}'Y$$

The variance matrix is consistently estimated by

$$\hat{V}(\hat{\theta}_{2nd-step})=(\hat{Z}'\widetilde{X})^{-1}\hat{Z}'D\hat{Z}(\widetilde{X}'\hat{Z})^{-1}$$

where D is a $n \times n$ diagonal matrix with entries given by the squared residuals from this second step.

3. Data and descriptive statistics

We use register data from the Discop East 2008. The Discop East is the largest audio-visual market organised annually in Budapest. We use the data from the organiser's register where participants reveal the meeting among themselves. Our network measures are constructed on the basis of these meeting data. Two firms revealing a meeting in the register are considered to be connected.

The register provides information about 1029 participant firms – their characteristics and the meetings. Descriptive statistics of the data are provided in Table 1. The variable of our interest is an index of diversification. We use an additive index of the number of products and services that a company trades. There 26 products and services considered in the index. The table shows that the diversification index has an average of 8.7. The maximum number of products and services is traded by 4 companies. There is a considerable variance in the index as shown by the high standard deviation.

Table 1 also gives the descriptive statistics for company characteristics and the country of the company (the country where the company is registered). The company characteristics have three broad categories – content acquisitions, content supplier and support services. This set of variables control for the observed heterogeneity of firm activities. There are not mutually exclusive categories as some companies belong to more than one category. Detail break down under each broad category is presented in the table. Most prevalent characteristics in each broad category are – territorial distributor (51.2%), finished program supplier (57.5%), and production services among the support services.

The last block of numbers in the tables shows country break down. We have reported the countries that have al least 1% representation in the market. It shows that France, Germany, Hungary, Russia, U.K. and U.S.A each represent more than 5%. The high representation of Hungarian companies is explained by the organisation of the market in Budapest.

Table 1: Descriptive statistics

	Mean	Std. Dev.
Diversification index	8.702	5.364
(An additive index comprising 26 products and services)		
Company characteristics		
Content acquisitions		
TV station	0.293	0.455
Television service provider	0.102	0.303
Territorial distributor	0.512	0.500
Content supplier		
Finished programs	0.575	0.495
Scripted formats	0.201	0.401
Unscripted formats	0.207	0.405
Packaged channels	0.059	0.236
Support services		
Advertising	0.052	0.221
Laboratory	0.108	0.310
Production services	0.121	0.327
Country		
Bulgaria	0.011	0.103
Canada	0.017	0.131
Croatia	0.011	0.103
Czech Republic	0.028	0.166
France	0.067	0.250
Georgia	0.013	0.112
Germany	0.051	0.219
Hungary	0.099	0.299
Israel	0.017	0.128
Italy	0.025	0.157
Macedonia	0.014	0.116
Netherlands	0.023	0.151
Poland	0.044	0.205
Romania	0.028	0.166
Russia	0.079	0.269
Slovakia	0.014	0.116
Spain	0.030	0.171
Turkey	0.031	0.174
Ukraine	0.041	0.198
U.K.	0.118	0.322
U.S. A.	0.067	0.250
Serbia	0.044	0.205
Number of companies		1029

The network of companies is constructed on the basis of their links among them as revealed in their meeting records. An average company has 7.5 contacts in the network. Tables 2 gives the cross tabulation of ranges of contacts and mean value of diversification index.

Table 2: Network and diversification

Number of contacts (Average = 7.5)	Percentage of companies	Diversification Index (mean value)
Less than 5	48.105	8.067
Between 5 and 10	28.183	8.714
Between 10 and 20	16.035	9.909
Between 20 and 30	4.956	9.961
More than 30	2.721	10.393

The table shows that 48% companies are linked with less then five companies. There are 28% companies with 5 to 10 contacts and 16% with 10 to 20 contacts. Only 7.7% have more than 20 contacts. The mean values of the diversification index for different intervals of contacts show a positive correlation between number of contacts and diversification index. Apparently, higher the number of contacts a company has higher is number of products and services it trades. However, higher number of contacts does not necessarily mean higher diversification of the contacts. In the econometric analysis below we put this hypothesis of network effect on diversification to empirical test.

4. Econometric results

We use the methodology developed by Bramoulle et al. (2009) and presented in Section 2 to estimate the network effect on product diversification. As explained in Section 2, we use a network transformation in order to eliminate correlated effect, and use 2SLS method to disentangle endogenous and exogenous network effects. Table 3 presents the estimation results.

The network effect, precisely the endogenous network effect, on product diversification is presented in the first two columns. It shows that product diversification of a company's network contacts has a positive significant effect on its product diversification. In other words, higher the average diversification index of a company's network contacts, higher is the range products and services it trades in the market. Estimates of effect of company characteristics are given the middle columns. It appears that companies that supply unscripted formats have a higher variety of products and services. Other dummies for company category are not significant at reasonable levels.

Turning to the country dummies, we find that companies from Canada, Georgia, Hungary, Romania and Turkey have lower product diversity. On the other hand, companies from Italy and Macedonia have higher product varieties.

Estimates of exogenous network effects provide quite interesting results (last three columns). Companies whose contacts are mostly suppliers of finished programs have lower diversification index. On the contrary, when a company is connected with contacts that are suppliers of packages channels or production services it tend to offer a larger variety of products.

Turning to the country dummies we find that the companies connected with companies from Bulgaria, Hungary and Poland have lower product diversification. And the companies connected with companies from Israel, Italy, Ukraine, UK and USA companies have higher product diversification. This positive effect is highest for being connected with companies from Israel, followed by USA companies. This might reflect the dominance of these countries in the audio-visual industry as well as their technological advancement that drives their dominance.

Table 3: Estimation results – network effects

	Endogenous network effects: (I-G)GY		**Own characteristics: (I-G)X**		**Exogenous network effects: (I-G)GX**	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Endogenous effect	0.146 **	0.057				
Company characteristics						
TV station			-0.028	0.485	-0.184	0.125
Television service provider			-1.018	0.760	-0.036	0.165
Territorial distributor			-0.917	0.704	0.009	0.145
Finished programs			-0.563	0.700	-0.355 **	0.144
Scripted formats			-1.469	1.076	-0.090	0.264
Unscripted formats			2.183 *	1.161	-0.240	0.278
Packaged channels			-0.869	1.026	0.418 *	0.246
Advertising			1.793	1.470	0.323	0.337
Laboratory			0.205	0.934	0.050	0.168
Production services			1.034	0.815	0.427 *	0.249
Country						
Bulgaria			3.281	2.497	-1.640 **	0.794
Canada			-3.815 **	1.888	-0.381	0.408
Croatia			1.730	1.654	-0.465	0.297
Czech Republic			0.521	1.489	-0.064	0.312
France			-0.806	1.141	0.178	0.194
Georgia			-3.721 **	1.857	-0.491	0.349
Germany			-1.843	1.182	-0.254	0.200
Hungary			-2.176 *	1.182	-0.360 *	0.206
Israel			-1.279	1.947	0.769 *	0.412
Italy			3.538 *	1.847	0.918 **	0.465
Macedonia			4.310 *	2.548	-0.237	0.374
Netherlands			-0.297	1.840	0.088	0.252
Poland			1.423	1.170	-0.573 **	0.280
Romania			-3.756 *	2.171	-0.244	0.410
Russia			-1.199	1.039	0.305	0.211
Slovakia			-2.796	2.348	0.422	0.309
Spain			-1.625	1.715	-0.120	0.290
Turkey			-3.896 ***	1.425	-0.015	0.200
Ukraine			-0.547	1.133	0.662 **	0.324
U.K.			-0.169	0.997	0.561 *	0.287
U.S. A.			0.363	0.958	0.760 **	0.295
Serbia			-1.542	1.190	-0.049	0.217
Number of observations						1029

Note: ***, ** and * stand for significance at 1%, 5% and 10%, respectively.

We check the robustness of our results using different set of variables. Since the company characteristics are always recorded as dummy variables the list of control variables can be broadened incorporating other dummies. However, the results remain similar with endogenous network effect always positive and significant. They indicate that business network plays an important role for the product diversification in audio-visual market.

5. Conclusion

This paper has studied the network effect on product diversification in audio-visual market in East Europe. Despite the dimension and importance of the market for the European economy, very little research has focused on this market. This gap is strikingly apparent in the area of the link between network and product diversification.

We use a novel methodology that accounts for the difficulties encountered by previous empirical studies on network effect. The methodology used is able to disentangle endogenous network effect from exogenous effect after eliminating correlated effect by network transformation. We find that business networks exert a significant positive effect on the product diversification of companies in audio-visual market. Higher the diversity of product of a company's business contacts, so is its own. The result has important implication for business strategy in the era of digitalisation and creation of single market in Europe under a uniform set of institutions.

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