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BEING CENTRAL AND PRODUCTIVE? EVIDENCE FROM SLOVENIAN VISUAL ARTISTS IN THE 19TH AND 20TH CENTURY

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Being Central and Productive?
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Abstract

Slovenian art history has received very little (if any) attention from the viewpoint of network theory although there were several examples of artists co-working or working in groups, collectives or even loosely organized clusters (groups from the impressionist Sava in 1904 to postmodern Irwin in 1984). This may be interpreted as a way to acquire better positions in the national and international art circles and on the art market. In our article we use web-based dataset of Slovenska biografija (operated by the Slovenian Academy of Sciences and Arts), which contains data on numerous notable persons throughout Slovenian history to analyze the centrality of individual artistic figures and movements throughout Slovenian art history. We also study the influence of network centrality on cultural production controlling for endogeneity following the instrumental variable approach, proposed in the literature while using a new instrumental variable to solve the problem. Finally, we present results which show that women visual artists used their network positions more intensively than men and provide some first explanations for this observed relationship. In conclusion, we provide some reflections on the importance of these findings for further research work in the area.

Keywords: Slovenian art history, social network analysis, network centrality, artist productivity, instrumental variables, women visual artists

JEL classification: D85, J49, N70, Z11, C36, C38, C45

1. Introduction

Slovenian art history has been researched in numerous publications and is one of the fields in Slovenian humanities with longest tradition. Yet, surprisingly little attention has been provided to the perspective of the network theory and groups of artists throughout history. Are the artists more productive when forming and working in groups? Is there any special influence of the confounding variables, such as gender, age, occupation, income? Are there any spillovers between artistic sectors – do the "transdisciplinary" groups such as Dada and Bauhaus show that not only is connectedness within one art sector important, the key is to connect with artists from as diverse fields as possible? Such questions have been posed and partially and/or fully answered in previous years, within the scientific literature (e.g. O'Hagan and Hellmanzik, 2008; Hellmanzik, 2009a; 2009b; 2010; 2012; O'Hagan and Borowiecki, 2010; Borowiecki, 2013; O'Hagan and Walsh, 2015; Mitchell, 2015; Kuld, 2015) of mainly arts and art history domains. Although social network analysis has been used in studying artists previously (e.g. McAndrew and Everett, 2014; Baia Curioni, 2012, Baia Curioni et al., 2013), and the question on the effects of networking on productivity of the artists has been solved by means of predetermined geographical-historical clusters (see previously quoted literature, e.g. Borowiecki, 2013), the possibilities of social network analysis in analyzing the effects of artists productivity have not been explored yet.

One strand of literature as summarized in Borowiecki (2013) studies the effects of geographical clustering on productivity. Borowiecki follows Glaeser et al. (1992) in outlining three formal theories of a benefit associated with geographic clustering. The first theory argues that geographic proximity facilitates spillover effects between firms in an industry (e.g. Marshall, 1890) and the cost of transmitting knowledge rises with distance. The second theory, proposed by Jacobs (1969), states that the most important knowledge transfers come from the outside of the core industry and dissemination of complementary knowledge between economic agents of diverse backgrounds should facilitate innovation. Therefore, in a geographic cluster, the presence of a high degree of diversity might potentially lead to increasing returns. The third theory dates back to Porter (1990) who argues that local competition in specialized, geographically-concentrated industries is the biggest stimulus for growth – the presence of multiple rivaling individuals should be the source of important incentives for out-performing the competitor.

On the other hand, theory also advocates for the relationship between network centrality and productivity effects. One strand relates to relationship between network centrality and entrepreneurial success (e.g. Maritz, 2010), another to relationship between social networking and employee productivity (e.g. Aguenza and Som, 2012; Martensen et al., 2011; Beck, 2007). Nevertheless, to our knowledge neither has so far such effects been estimated for artists (although some studies deal with the effects of networking in art firms, see e.g. Konrad, 2013; Klerk and Saayman, 2012; Kuhn and Galloway, 2015) nor on historical data. It is our task, therefore, to verify, on one hand, whether any positive effects of networking on productivity of visual artists can be found in historical data, and, on the other, whether such effects were dependent upon the gender of the artists. Our proposition is that such effects can be found and affecting the productivity of men differently than women.

Using a web-based database of *Slovenska biografija* – which has not been utilized so far – we indeed demonstrate that networking is beneficial for the artistic productivity, yet to a slightly smaller scale and/or significance as was speculated in some previous studies based on geographical clustering. We are able to control for the apparent endogeneous, reverse causal

relationship in the model (see e.g. Borowiecki, 2013) using an innovative, new instrument. Moreover, we firstly determine the empirical effects of other confounding covariates, and, secondly, the different utilization of network positions of men and women visual artists throughout Slovenian history. Finally, this study is probably the first network analysis and empirical description of the main artistic groupings of the 19th and 20th century of the Slovenian art history.

The article is structured in the following manner. In the next section, we provide a short literature review and theoretical underpinnings. In the third section, we present the dataset and used methods. In the fourth section, we provide the results from our social network analysis. In the fifth section, we will present the econometric results. In the sixth section, we will present the results of modelling of gender effects. We conclude by reflecting on the findings and possibilities for future research.

2. Art historical overview

Slovenia only became a federal republic in the framework of the Socialist Federal Republic of Yugoslavia. It seceded and became an independent country in 1991. Slovenia spent all the previous centuries under foreign rule, mainly under Austria-Hungary and – on its Western border – under Italy. Therefore, it stands to reason that up to around the end of the 20th century, we mainly refer to art on Slovene lands, since the fine arts were generally the purview of foreign artists which the local gentry hired to furbish and construct houses, palaces, churches and altars; they also commissioned portraits and imported increasingly cheaper reproductions from abroad. The Turkish raids, social upheavals, religious battles and occasional epidemics, which plagued the 16th century, prevented these lands from developing further. However, in the 17th century, baroque, in addition to gothic art, left a deep imprint on Slovene lands (Stele, 1966; Höfler, 1999).

At the time, the Church, especially the Society of Jesus and Tomaž Hren, the Mayor of the Slovene capital city of Ljubljana, represented an integral part of the social network. Since Hren could not afford his own opulent court, he made due with part-time artists, while the other rare commissions were also done by foreign artists, mainly from Lombardy, Venice and Friuli.

The other important circle of people was the so called Academia Operosorum Labacensium (Academy of the Industrious Residents of Ljubljana). It was founded in 1698 by the Carniolan intelligentsia and patriots, the three most important founders being members of the Dolničar family (a cathedral cleric, a jurist and his son). This circle set out to culturally reform the lands, where artists were still mainly being imported from Venice, establishing important ties with the Italian city of Udine. As a follow-up of the economic development there was a construction boom in Ljubljana which also turned out to be a great opportunity for local fresco painters and builders (e.g. Franc Jelovšek and Gregor Maček), who belonged to the Venice School. At the other end of the country, in Styria, the circle around the house of Attems, a noble aristocratic family which set out to refurbish their castles in Styria. The presence of foreign fresco painters proved to be an opportunity for local artists.

The rule of Empress Maria Theresa was marked by austerity, making it a less than propitious time for the fine arts. At the same time, ties with Vienna grew ever more important, while those with Italy languished – it was this route, passing through impoverished Ljubljana, a city unable to provide enough work for more than a brief stay, which was taken by builders, painters and

other artists. Local artists, in their battle for a larger slice of the pie, relied on institutions, protecting their privileges from foreigners. At the turn of the 20th century, national consciousness and the awareness of belonging to a community of similarly-speaking nations mainly gave rise to new literature. The Slovene intelligentsia had no particular interest in the fine arts. Even writers and poets would usually adorn their homes with only one or two holy cards bought at the village fair, and not with expensive oil paintings and sculptures (Stele, 1966; Höfler, 1999; Trenc-Frelih, 1998).

The 19th century gave rise to academies of fine arts in political and urban centers, which replaced the role of painting and holy card workshops. They were attended by local artists who first travelled to Vienna (among them were Franc Kavčič, who even became a lecturer and director of the Academy of Fine Arts, the first Slovene career artist, Lovro, Valentin and Anton Janša, as well as Carl Sütz), then Bologna, Rome, Mantua and Venice; afterwards, Munich started becoming ever more popular, while in the countryside, holy card workshops continued to operate, the most important being the Layer House in Kranj.

The giant of Slovene poetry, the romantic poet France Prešeren, struck up a friendship with painter Matevž Langus. After 1829, the latter became the central figure of artistic creation in Ljubljana, leaving behind not only portraits of his contemporary important local patrons, but also furnishing the majority of Ljubljana churches with art produced in his workshop. He was joined by painter Mihael Stroj. Anton Karinger and Marko Pernhart, two landscape artists belonging to the Vienna School, were also important for Ljubljana. Pernhart came from the Klagenfurt area. Then there was Ivan Zajec, the first academy-educated Slovene sculptor. He was later joined by Alojz Gangl. During this period, the Littoral region was marked by artist Franc Tominc, who belonged to the School of Rome, while Styria was greatly influenced by strong ties with the Austrian city of Graz. Local and oftentimes amateur painters also began to work in smaller Slovene towns, for example in Ptuj, Novo Mesto and Celje. The Venice-educated Janez Wolf, the central representative of religious art at the time, founded an important painting workshop which produced two important painters of the next generation, the brothers Janez and Jurij Šubic. Both had strong ties to Vienna.

The turn of the 20th century turned out to be pivotal for Slovene art: "The fine arts assumed the central role in society's civilizational identity and were fully in line with European currents […], catching up with literature and music, even completely surpassing them when it came to architecture (Jože Plečnik and Maks Fabiani), meaning artistic language became a reputable herald of the modern conceptual and representational orientation of Slovene society. Not unlike literature's role in Slovene national development, the fine arts also became a constitutive part of national identity, intellectually ennobled to the rank of *artes liberales*. At the same time, it claimed the characteristics and elements of its own proper institutional organization (exhibitions and galleries), professionalization (school of art, plans for an academy, the formation of professional societies and 'secessions'), and reception (art criticism, aesthetics, and theory of art)." (Brejc, 1998: 217).

For the first time, artists became true professionals. During this period, the art school founded by Anton Ažbe in Munich played a decidedly prominent role. Ljubljana was also home to two professional societies: the Society for Christian Art (from 1894) and the Slovene Art Society (1899–1904). The first was mainly dedicated to religious art and followed the philosophy of Neo-Scholastic idealism, which had numerous followers among philosophers in the region, while the second was a trade union organization, dedicated to representing the social and professional interests of its members; in 1900, it organized the first art exhibition. However, it

was dissolved soon afterwards due to infighting. The central role was quickly assumed by the artist Rihard Jakopič and three other fellow painters – all impressionists going against traditional artistic currents. They simultaneously established an important social network, which to a certain extent enabled them to professionally work and develop their artistic system. This tactic was significant enough as to enable art historian Beti Žerovc to write the following opening lines in her aptly titled book, Rihard Jakopič: Artist and Strategist (Rihard Jakopič, umetnik in strateg): "When examining the fine arts during the first half of the previous century, Rihard Jakopič crops up in all manner of places, especially at 'intersections' where art is embedded in its environment – more so than any other Slovene artist. He was regularly involved in various 'non-artistic factors and endeavours' in art, such as the market, cultural policy, politics, history, ideology, etc. In other words, in areas all too often ignored by the fine arts. If not taboo, they are generally as limited as possible, since their non-artistic nature makes them undesirable or seen as trivial, perceived as not taking part in the canonization of artists, the construction of history and hierarchy in the artistic field, etc. They are seen as being limited to the present, while history is bound to show the true nature of art, justly – and solely based on looking at works of art – separate the wheat from the chaff." (Žerovc, 2002: 9).

The second exhibition of Slovene art, presented in 1902, already acquired a much more professional air. The already mentioned four impressionist painters were already on the scene: Rihard Jakopič, Matija Jama, Ivan Grohar and Matej Sternen. This group would henceforth set the pace and steer the development of Slovene art (Brejc, 2004; Trenc-Frelih, 1998; Kržišnik, 1979). In 1904 and by occasion of the exhibition in Vienna, they named themselves the Sava Club, therefore separating themselves from the other members of the Society of Slovene Artists. Their work was lauded by Slovenian writers (Ivan Cankar and Oton Župančič) and they quickly took over the artistic scene (especially Jakopič). Their artistic output was featured by exhibitions in Belgrade, Trieste, London and the Vienna Secession (see e.g. Mikuž, 1995; 1979). In 1909, they exhibited their art in the newly-opened Jakopič Pavilion, managed by Rihard Jakopič. The other group at the time, the more extensive *Vesna*, which was based on an ethnographic character (the members are sometimes called Vesnani/"The Vesnans"), could not hold a candle to them (among others, it included artists such as Šantel, Gaspari, and Smrekar). The impressionists became the torch bearers of "folk" Slovene art, despite the fact their paintings were based on French and later other international influences (see Kranjc 2001; 2004; 2005-2006).

In the 19th century, architecture was in search of its own "national identity" mainly through the work of a trio of architects educated abroad: Jožef Plečnik, Maks Fabiani and Ivan Vurnik. Not unlike Vesna's members, the latter occasionally drew inspiration from folk motifs. Once again, the Mayor of Ljubljana (this time Ivan Hribar) played a pivotal role. Through his studies, he was attached to the more developed city of Prague and searched for Slavic sources. The other two architects were doing much the same in Vienna, but on a much grander scale. Especially Jože Plečnik developed important ties with Prague with the help of President T. G. Masaryk.

When it came to painting, the Youth Club proved to be especially important for the next generation (see e.g. Gabrič, 1995). First known as a gathering place for writers and musicians (Anton Podbevšek, Josip Vidmar and Marij Kogoj), it soon attracted the attention of artists. After its dissolution, France Kralj founded the Club of Young Artists which would later become the Slovene Society of Art, bringing together arts, mainly expressionists (Tone and France Kralj, Božidar Jakac). With the founding of the Academy of fine arts and the Museum of Modern Art immediately after the second world war, the posts at the museum and the academic

positions became important networking positions, a situation that remains valid well into our times (Božidar Jakac, Gojmir Anton Kos, Marij Pregelj, Gabrijel Stupica).

3. Data and Method

In our analysis we use dataset of *Slovenska biografija*, which is a web-based encyclopedia in Slovenian language, provided and managed by the Research Centre of the Slovenian Academy of Sciences and Arts. The encyclopedia includes information on numerous important figures in Slovenian history, grouped under 15 headings: Social sciences and services; Public Administration; Spiritual Occupations; Humanities; Agriculture and similar areas; Museums, libraries and archives; Natural and mathematical sciences; National advantageous; Craftsmen; Business persons and landlords; Entertainment and sports; Technical and technological sciences; Arts; The Army; Health care. To our knowledge, although rich in content, it has never been used before for the purpose of network analysis, which provides our analysis a special importance.

To our study, we select the data for the visual artists, including the following occupations (in parentheses are numbers of included cases; the classification is based on the original database):

Painting:
Academy painters (6);
Aquarelle (1);
Church Painter (1);
Fresco (1);
Illuminates (3);
Illustration (19);
Caricature (3);
Landscape painters (2);
Miniature (2);
Navy painter (1);
Drawing (17);
Scene painters (2);
Silhouette (1);
Painters (297);
Painters – self-made[1] (5);

Graphics:
Ex-Libris (1);
Copper-cutting (12);
Graphic workers (1);
Graphics (35);
Lithographs (2);
Lithograph painters (1);

Sculpture:
Academy sculptor (4);
Sculptors (56);
Sculptors – self-made[2] (3);

[1] I.e. with no academic background.
[2] I.e. with no academic background.

Design:
Designers (6);
Graphic Design (1);

Restoration:
Model makers (1);
Restoration (6);

Other visual artists:
Decoration (1);
Ceramics (2);
Modelers (1).

The following variables - manually constructed from the web-based encyclopedia - are used in our analysis (the choice of the variables is based on the available data in the web-based encyclopedia):

- *Century of birth* (we include data only on the visual artists from the 19th and 20th century);
- *Gender*: binary variable, taking the value of 1 for females and 0 for males;
- *Age*: for living artists their current age, for the already passed-away ones the age at their death;
- *Multiple roles*: number of different occupations the respondent is listed at the database;
- *Occupation*: the main occupation the respondent is listed at (the first on the list in the biography);
- *Productivity*: length of the biography, excluding authors name and references – such usage is justified by previous analyses of e.g. O'Hagan and Borowiecki (2010) and Borowiecki (2013)[3].

Some descriptive statistics of the above variables are presented in Table 1. We list only the results for those respondents, included in our network and econometric analysis, which limits our sample to 214 cases/observations. We see that the productivity variable is skewed with clear outliers at the right end of the distribution. Median length of the biography amounts to 337 words. In our analysis, there are significantly more artists born in 19th century, about 70%. Moreover, females are extremely underrepresented in the sample, amounting to only about 12% of all respondents. Additionally, approximately 85% of included artists are/were of age higher than 50 years. Slightly less than one half of them are listed in multiple roles. Among the occupations, painters are in the large majority, followed by sculptors and illustrators.

Table 1: Descriptive statistics of main used variables

	Mean	Median
Productivity/wordcount	463.35	337.00
	%	n
19th century	70	144
20th century	30	62
Female	12	24
Age (>50)	85	172

[3] It is of course possible that the measure is biased. We, therefore, take great care in our interpretations of results of econometric testing.

Multiple roles (>1)	44	90
Illustrator	6	12
Sculptor	14	29
Drawer	2	5
Painter	71	147
Other	6	13
Total	**100**	**214**

Source: Own calculation.

The main variable we use in the analysis relates to network centrality; it is defined as measure of connectedness with other artists in the sample. Our methodology mainly derives from the social network analysis defined as a process of investigating social structures through the use of network and graph theories (see e.g. Barnes, 1954[4]; Bott, 1957; Otte and Rousseau, 2002; McAndrew and Everett, 2014), controlling for endogenous network formation (see e.g. Goyal and Joshi, 2003; Soramaki et al., 2007; Hiller, 2014). Social network analysis emerged as a key technique in modern social sciences in recent years, as demonstrated in largely growing literature in the field (see e.g. Freeman, 2006). It has gained a significant following in several research fields: sociology, anthropology, biology, communication studies, mathematics, statistics, economics, geography, information science, organizational studies, social psychology, computer sciences and sociolinguistics[5].

In its first incarnation, modern social network analysis was introduced by a psychiatrist, Jacob L. Moreno, and a psychologist, Helen Jennings which conducted elaborate research, first among the inmates of a prison (Moreno, 1932) and later among the residents in a reform school for girls (Moreno, 1934). In contemporary forms, social network analysis is being transferred also in natural sciences such as physics (see e.g. Watts and Strogatz, 1998; Girvan and Newman, 2002; Holme, Huss and Jeong, 2003; Kolaczyk, Chua and Barthelemy, 2007; Newman, 2006) and biology.

Scholars such as Berkowitz (1982), Borgatti and Everett (1992; 1997), Burt (1982), Carley (2003), Faust and Wasserman (1994), Freeman (2006), Granovetter (1973; 1985; 1994), Knoke (1981; 1983), Krackhardt (1989), Marsden (1982), Mullins (1973), Rapoport (1963), Wellman (1979; 1988a; b) and White (1988) expanded the use of systematic social network analysis.

According to Freeman (2006), several analytic tendencies distinguish social network analysis from the traditional approaches and techniques in social sciences, namely: a) there is no assumption that groups are the building blocks of society – the approach is open to studying less-bounded social systems, from non-local communities to links among websites; b) rather than treating individuals (persons, organizations, states) as discrete units of analysis, it focuses on how the structure of ties affects individuals and their relationships; c) in contrast to analyses that assume that socialization into norms determines behavior, network analysis studies the extent to which the structure and composition of ties affect norms.

[4] In 1954, J. A. Barnes started using the term social network analysis systematically to denote patterns of ties, encompassing concepts traditionally used by the public and those used by social scientists: bounded groups and social categories.

[5] For the application in social environments see Burt, Minor and Associates, 1983; and Wassermann and Faust, 1994; for the field of economics in particular see Dutta and Jackson, 2003.

As stated by Freeman (2006), it is the shape of a social network that helps determine a network's usefulness to its individuals. For example, smaller, tighter networks can be less useful to their members than networks with lots of loose connections (weak ties) to individuals outside the main network, while more open networks with many weak ties and social connections are more likely to introduce new ideas and opportunities to their members than closed networks with many redundant ties. It is better for individual success to have connections to a variety of networks rather than many connections within a single network. The power of social network analysis stems from its difference from traditional social scientific studies, which assume that it is the attributes of individual actors that matter. Social network analysis produces an alternate view, where the attributes of individuals are less important than their relationships and ties with other actors within the network.

In cultural economics, several usages can be noted. In the economics of music, studies by Becker (1982), Faulkner (1983), Finnegan (1989), Crossley (2008) and Bottero (2011) led the development in the field. In recent years, a notable study by McAndrew and Everett (2014) was presented, studying the case of British classical composition, both as an example of a music network, and to contribute to debates in music history. It demonstrated that for the British composers, access to elite networks depended both on ability and personality; while many talented marginal figures were undoubtedly simply unlucky in that they possessed all the 'right' attributes but somehow did not break through, others were marginal partly through personal choice and self-imposed isolation. Some composers chose more commercial paths with less need for network support. Others chose to compose music, which was difficult to program or publish (McAndrew and Everett, 2014: 20).

In our study, we use models from endogenous network analysis, trying to answer to these three key questions: 1) Which were the main central figures with most social capital in Slovenian art history and did they form part of larger networks? 2) What is the relationship between network centrality and cultural production, after controlling for the apparent endogeneity in the model? 3) Were positions of women in the artist networks any different than men and for what reasons? Our assumption is that the ones with better connectedness will likely be more productive, while the ones more productive will also likely be more connected. We answer the latter question using an instrumental variable empirical strategy, adopting one of the measures of centrality apparently unrelated to production as an instrument.

Finally, we explore the different relationship between network centrality and productivity regarding women as compared to men. We expect that women would tend to use their network position more intensely as they were clearly deprivileged in artistic recognition and when reaching a better position, one would expect that this would positively contribute to their productivity even *more than for men* with comparable empirical characteristics.

In general, social network analysis seems the best strategy to answer the above questions, which strongly relate to the theories of relationship between artistic productivity and clustering, presented at the beginning, and answer them in a new sense exploiting the possibilities of the previously unused dataset. Our usage of network analysis is not justified only by the novelty and relatively limited application in cultural economics, but it mainly relies on the need to complement the existing knowledge of the relationship of clustering and artistic productivity, based on the actual and not geographical relationships between the artists.

The main hypotheses we want to test, therefore, are the following:

H1: Networks in Slovenian art history of 19th and 20th century closely followed the art historical movements of the time.

H2: We can find significant and positive effects of network centrality on artistic productivity even after controlling for the endogenous relationship between the two variables.

H3: We can also find significant effects of age, gender, century of living, artistic occupation and multiple artistic roles' holding on artistic productivity.

H4: The effects of networking on productivity were significantly different for women than for men (we expect that women will have a stronger effect of networking on productivity).

As confirmed in the existing body of literature (e.g. Goyal and Joshi 2003; Soramaki et al. 2007), in the social network analysis we use four main parameters as defined below:

- *Degree centrality*, an example of radial centrality, placing centrality from walks of length one;
- *Eigenvector centrality*, placing centrality from walks of infinite length;
- *Betweenness centrality*, an example of medial centrality, denoting the number of shortest paths which pass through the given vertex;
- *Closeness centrality*, the total geodesic distance from a given vertex to all other vertices.

The *degree centrality* of a vertex v, for a given graph $G := (V, E)$ with $|V|$ vertices and $|E|$ edges, is defined as simply $C_D(V) = \deg(v)$ (see also Freeman, 1979).

The *eigenvector centrality* can be defined in the following manner (see also Newman, 2006). For a given graph $G := (V, E)$ with $|V|$ number of vertices we defined $A = (a_{v,t})$ as the adjacency matrix, i.e. $a_{v,t} = 1$ whether vertex v is linked to vertex t, and $a_{v,t} = 0$ otherwise. The centrality score of vertex v can be defined in this manner as:

$$x_v = \frac{1}{\lambda} \sum_{t \in M(v)} x_t = \frac{1}{\lambda} \sum_{t \in G} a_{v,t}\, x_t$$

with $M(v)$ a set of neighbors of v and λ a constant. Rewriting in a vector notation provides the eigenvector equation:

$$Ax = \lambda x$$

where λ's are the eigenvector solutions to this equation. The v'th component of the related eigenvector, finally, provides the relative eigenvector centrality score of the vertex v in the network.

The *betweenness centrality* can be represented as (see Brandes, 2001):

$$C_B(v) = \sum_{s \neq t \neq v \in V} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

where σ_{st} is total number of shortest paths from node s to node t and $\sigma_{st}(v)$ is the number of those paths that pass through v.

Finally, as for the *closeness centrality*, we define the farness of a node x as the sum of its distances from all other nodes, and its closeness as the reciprocal of the farness (see also Bavelas, 1950; Sabidussi, 1966), that is:

$$C_C(x) = \frac{1}{\sum_y d(y,x)}$$

Those measures enable us to study the position of our artists in the network in the best possible manner and consequently to answer the questions and test the proposed hypotheses.

4. Results – Network analysis

In Figures 1 and 2 we present results of the circular network representation of our sample. When clustering the artists on members similarity of the cluster and their belonging to a certain historical movement or artist genre, we obtain six large groups which are related to the general historical artistic movements (The Impressionists, The Modernists), historical time (The Old Masters), Slovenian-specific art scene (The "Vesnans", The Layer's workshop), and, finally, genres and types of visual art (The "Sculptors"). Some artists belonged to different groups at the same time (e.g. Anton Karinger to The Old Masters; Alojzij Gangl to The Sculptors; most of "The Sculptors" to "The Modernists", etc.) and few can be even seen as representatives of another group, viewed form the existing art historical knowledge. Nevertheless, we consider the obtained groups very well match the actual positions of the artists in the existing Slovenian art history.

- *The Impressionists*: Edvard Wolf; Anton Karinger; Valentin Šubic; Pavle Šubic; Štefan Šubic; Rudolf Jakhel; Anton Ažbe; Pavle Šubic Jr.; Jurij Šubic; Janez Šubic Jr.; Janez Wolf; Janez starejši Šubic; Roza Sternen; Ivana Kobilca; Matej Sternen; Maks Koželj; Ferdo Vesel; Ljubo Ravnikar; Ksenija Prunk; Jurij Jurčič; Julij Lehmann; Anton Jebačin; Jožef Petkovšek; Simon Ogrin; Josip Macarol; Ivan Grohar; Rihard Jakopič; Janez Borovski; Peter Žmitek; Matija Jama; Matija Bradaška; Franc Rojec; Fran Zupan; Pavel Gustinčič; Zdenko Skalicky; Anica Zupanec-Sodnik; Mirko Šubic; Čoro Škodlar; Blaž Šubic; Anton Cej; Aleksander Roblek; Alojzij Šubic.

- *The Modernists*: Zvest Apollonio; Gabrijel Stupica; Walter Bianchi; Veno Pilon; Vladimir Stoviček; Ivan Kos; Božidar Jakac; Karla Bulovec; Vinko Turk; France Kralj; Gojmir Anton Kos; Marlenka Stupica; Marjan Vojska; Lucijan Bratuš; Maksim Sedej; Klavdij Ivan Zornik; Alojzij Šušmelj; Karel Zelenko; Marij Pregelj; Miha Maleš; Jakob Savinšek; Tinca Stegovec; Jože Trpin; Jean Vodaine / Vladimir Kavčič; Ive Šubic; Janez Sedej; Ivan Seljak; Savo Sovrè; Anton Kralj; France Slana; France Ahčin; Franc Zupet; Anton Sigulin; Evgen Sajovic; Mara Kralj-Jerajeva.

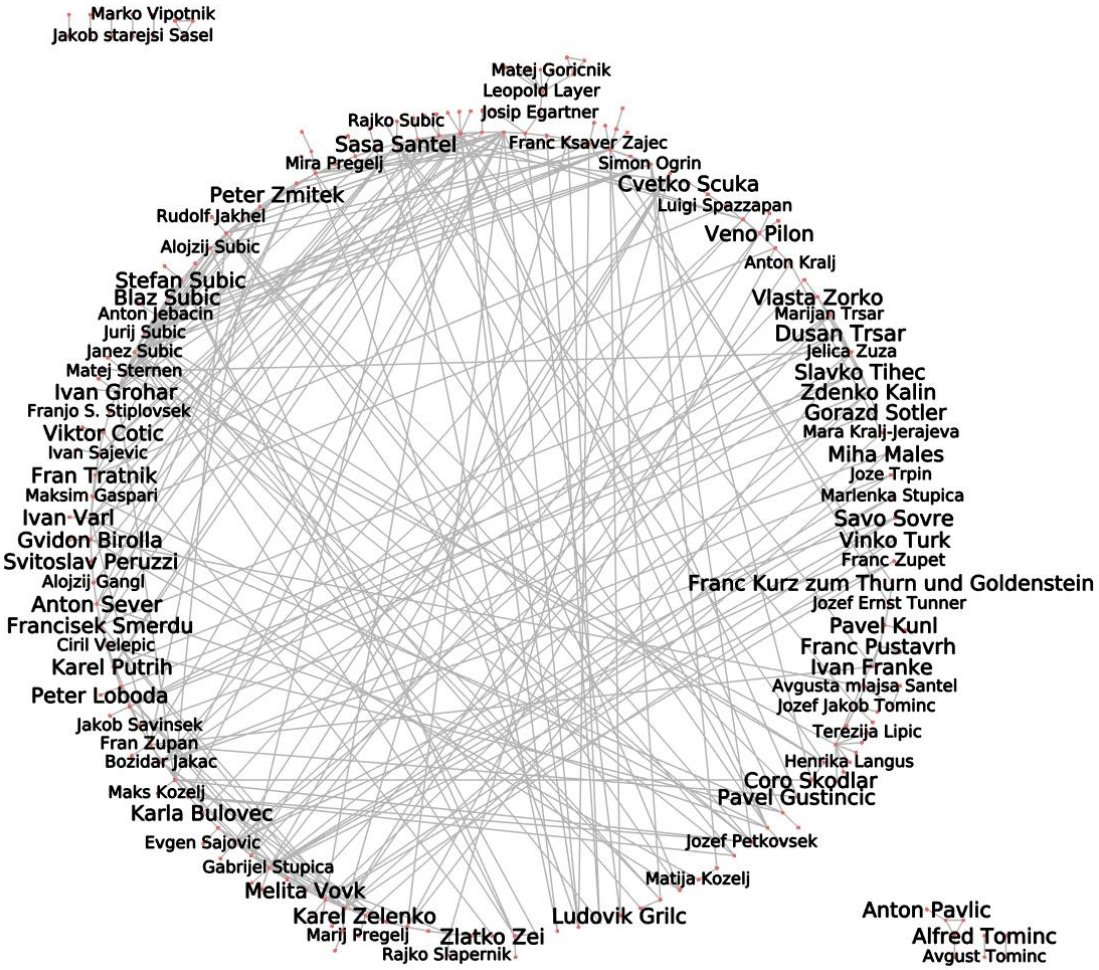
- *The "Vesnans"*: Vladislav Pengov, Franc Sterle, Alojzij Repič, Celestin Mis, Viktor Birsa, Luigi Spazzapan, Cvetko Ščuka, Valentin Kos, Saša Šantel, Rajko Šubic, plemenita Elza Kastl, Hinko Smrekar, Fran Tratnik, Julče Božič, Jože Srebrnič, Ivan Žnidarčič, Anton Sever, Maksim Gaspari, Janez Povirek, Ivan Varl, Ivan Sajevic, Anton Perko, Gvidon Birolla, Franc Klemenčič, Svitoslav Peruzzi, Alojzij Gangl, Matija Koželj, Gabriel Justin, Franc Mrčun, Elza plemenita Obereigner.

- *The Old Masters*: Viljem Künl, Pavel Künl, Terezija Lipić, Matevž Langus, Jožefa Struss, Mihael Stroj, Jožef Jakob Tominc, Josip Batič, Frančišek Caucig, Avgusta Šantel Jr., Jožef Ernst Tunner, Franc Kurz zum Thurn und Goldenstein, Josip Kogovšek, Janez Avguštin Puhar, Franc Pustavrh, Melita Rojic, Henrika Šantel, Henrika Langus, Ivan Frankė, Amalija Hermann von Hermannsthal, Alojzija Marija Jožefa Petrič.

- *The "Sculptors" (no special historical movement can be related to the members of this group while most of members are/were renowned sculptors)*: Vlasta Zorko, Slavko Tihec, Zdenko Kalin, Boris Kalin, Karel Putrih, Marijan Tršar, Melita Vovk, Dušan Tršar, Janez Weiss, Janez Vidic, Gorazd Sotler, Frančišek Smerdu, Marko Šuštaršič, Lojze Dolinar, Drago Tršar, Peter Loboda, Ciril Velepič, Avgust Andrej Bucik.

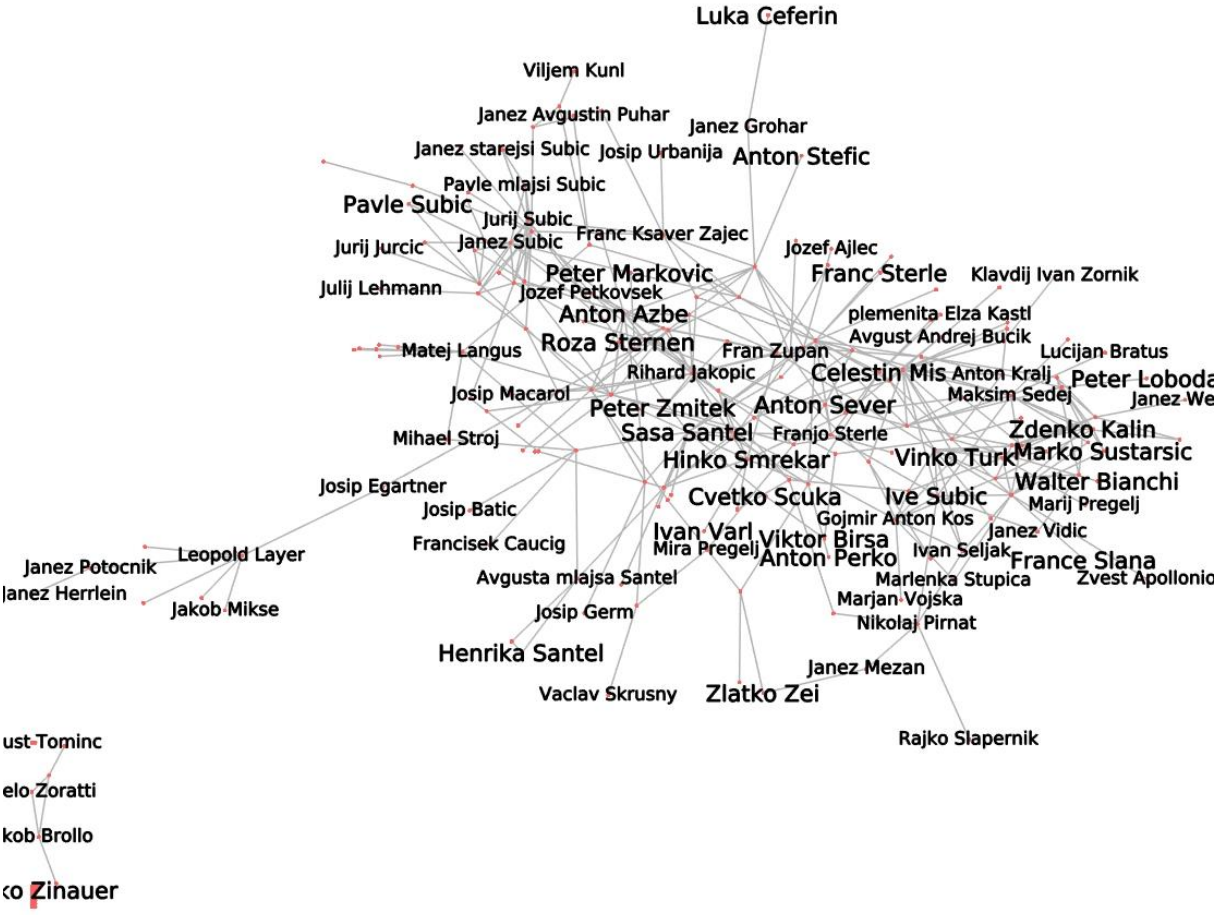
- *The Layer's workshop (based on the artist workshop of 19th century, led by Leopold Layer)*: Leopold Layer, Matej Goričnik, Anton Hayne, Jurij Miškovič, Janez Potočnik, Andrej Janez Herrlein, Josip Egartner, Jurij Tavčar, Ludovik Grilc, Jernej Jereb, Jakob Mikše, Gašpar Luka Goetzl, Franc Serafin Goetzl.

Figure 1: Visual representation of the analyzed network



Source: Own calculation.

Figure 2: Second visual representation of the analyzed network



Source: Own calculation.

In Table 2, we also list some basic characteristics of the analyzed network. Clearly, large discrepancy between average and median values of the four connectedness parameters (degree, betweenness, closeness, and eigenvector centralities) is noted. Particularly large is the difference in closeness centrality and betweenness centrality. Furthermore, there are seven connected components, which is an approximation for the number of clusters noted above. The graph density is very weak, indicating a large number of very weakly connected vertices, while the average geodesic distance is in the medium range (for more on this see e.g. Watts and Strogatz, 1998).

Table 2: Characteristics of the analyzed network

	Degree	Betweenness	Closeness	Eigenvector
Minimum	1	0.0000	0.0010	0.0000
Maximum	19	3606.720	1.0000	0.0041
Average	3.4579	285.4673	0.0877	0.0005
Median	2.0000	19.4277	0.0013	0.0002
Connected Components	7			

Single-Vertex Connected Components	0
Maximum Vertices in a Connected Component	433
Maximum Edges in a Connected Component	453
Graph Density	0.0045
Maximum Geodesic Distance (Diameter)	9
Average Geodesic Distance	3.16

Source: Own calculation.

In Table 3, we see the rankings of the main central figures, according to degree, betweenness and eigenvector centrality parameters. The key figure in degree and betweenness centrality is Alojzij Repič, an academy sculptor, being the educator of many key figures in the visual arts of that time. Also, several key impressionist figures can be noted (to no surprise): Rihard Jakopič, Anton Ažbe, Matej Sternen, Ivan Grohar, Matija Jama and Ferdo Vesel – all of them of course representatives of our Impressionist group. Furthermore, among "The Modernists", Gabrijel Stupica, Božidar Jakac and France Kralj stand out as key connected/connecting figures. Among the older artists, Janez Wolf is surely the key figure. Several "Vesnans" are also on the list, most notably Saša Šantel and Hinko Smrekar. Finally, Leopold Layer, the leader of the noted workshop of the 19th century also stands out as one of the key figures. It is interesting (but expected according to the societal structure characterizing the studied period) that no woman stands out as a key centrality figure, and that "The Vesnans" (Šantel, Smrekar) are not ranked well in terms of eigenvector centrality which could mean that although the Vesnans were well connected, their connections were not so well ranked in terms of importance (see e.g. Newman, 2001).

Table 3: Rankings of main central figures

Rank	Artist	Degree centrality	Rank	Artist	Betweenness centrality	Rank	Artist	Eigenvector centrality
1	Alojzij Repič	19	1	Alojzij Repič	3606.72	1	Rihard Jakopič	0.0406
2	Rihard Jakopič	16	2	Rih. Jakopič	3509.46	2	Anton Ažbe	0.0399
3	Anton Ažbe	14	3	Saša Šantel	2574.43	3	Ivan Grohar	0.0301
4	Gabr. Stupica	14	4	Jurij Tavčar	2140.04	4	Matej Sternen	0.0300
5	Janez Wolf	14	5	Mat. Sternen	2000.26	5	Janez Wolf	0.0251
6	Saša Šantel	13	6	France Kralj	1924.99	6	Matija Jama	0.0235
7	France Kralj	12	7	Jos. Egartner	1629.00	7	Jurij Šubic	0.0230
8	Matej Sternen	12	8	Janez Wolf	1558.44	8	Ferdo Vesel	0.0222
9	Božidar Jakac	11	9	Matej Langus	1515.87	9	Alojzij Repič	0.0209
10	Hink. Smrekar	11	10	Leop. Layer	1481.00	10	Janez Šubic Jr.	0.0203

Source: Own calculation.

5. Results – Econometric testing

Next, we perform some econometric tests to answer to the question on the relationship between network centrality and productivity. To this end, we firstly use basic Poisson models, taking into account the apparent count nature of the productivity variable.

Table 4 presents the results of the basic models, where we introduce the marginal effects of the used independent variables to the level of productivity. The results show that women tend to have lower productivity, as expressed by wordcount of their biographies (this could also be a consequence of their under-representedness in the sample and/or of the prevailing discrimination to women artists throughout the 19th and 20th century). As compared to men, women tend to have on average approximately 60-100 words shorter biographies which could be a consequence of women been much more seldom represented among the leading artists, in particular in the 19th century.

The coefficient on age is significant and shows the expected inverted (U-shaped) effect. Furthermore, those born in the 20th century tend to have on average approximately 100-180 more words in their biography. Additionally, illustrators, sculptors, drawers and painters tend to be significantly more productive than other visual arts occupations.

Finally, three of the four centrality parameters (i.e. degree, betweenness and eigenvector centrality) are strongly statistically significant and of the positive size. Due to their different construction, it is hard to make any sensible conclusions based on their marginal effects. On the other hand, the closeness centrality has an ambivalent and insignificant effect to the productivity of the artist which could be a sign that geodesic distance is/was not important for the productivity of Slovenian artists through 19th and 20th century which is a finding, interesting to explore in further research.

Table 4: Results of econometric testing, marginal effects, no endogeneity included

	Poisson regression - marginal effects		
	Model I	Model II	Model III
Female	-59.408***	-94.981***	-105.757***
Age	7.296***	5.201***	19.565***
Age square	-0.052***	-0.036***	-0.134***
Born 20th century	100.730***	124.154***	176.756***
Multiple roles	21.589***	13.578***	46.780***
Illustrator	110.151***	137.192***	114.852***
Sculptor	115.574***	121.195***	171.060***
Drawer	257.671***	327.589***	290.404***
Painter	163.362***	161.341***	134.897***
Degree c.	59.054***		
Betweenness c.		0.267***	
Eigenvector c.			26377.280***
N	203	203	203
Likelihood Ratio test	29784.03***	21551.86***	27530.53***
Log Likelihood	-18025.135	-22141.219	-19151.883
Pseudo R-square	0.4524	0.3274	0.4182

Note: Significance: *** - 1%; ** - 5%; * - 10%
Source: Own calculation.

To this end, we use closeness centrality as an instrument to control for the possible effects of reverse causality. As it shows up, the closeness centrality is a valid (uncorrelated to the error terms of original regression) as well as a strong (strongly correlated to all other three centrality

parameters) instrument. Using it as an instrument can provide a solution, improving the measures previously used by e.g. O'Hagan and Borowiecki (2010) and Borowiecki (2013), such as distance of the birthplace to the place of living. This opens up a place for several considerations. The possible reason for closeness centrality being the valid instrument, satisfying the exclusion restriction, could lie in (at least for Slovenia, but perhaps for the artists in general, which would of course have to be tested on other national or cross national datasets) the geodesic distance, which may matter much less than other types of network centrality for artistic productivity. This would mean that actual distances between artists play a minor role in the development of their network and their success – it is important to have many connections (e.g. degree centrality) without much regard to their final length in terms of connectedness of the network. This is clearly confirmed by the results of Table 2 (see previous section) showing that the analyzed network is very flat in terms of the density of connections.

The results in Table 5 below confirm the positive and (weakly) significant effect of the network centrality on artists' productivity even after controlling for the endogeneity. All three centrality parameters are in the level of significance of approximately 10%. This serves as another strong argument in the debate on the supposedly positive effects of networking on artists' productivity. Moreover, it serves as a confirmatory answer to our second research question: networking/connectedness indeed positively affects artists' productivity, particularly related to the degree centrality. Additionally, all the other control variables do not change in sign, although lose in the level of significance.

Table 5: Results of econometric testing, endogeneity controlled for using instrumental variables

	IV Poisson		
	Model I	Model II	Model III
Female	-0.189	-0.147	-0.239*
Age	0.025	0.019	0.040*
Age square	-0.000	-0.000	-0.000*
Born 20th century	0.235**	0.302**	0.366**
Multiple roles	0.068	0.034	0.084
Illustrator	0.263	0.317	0.284
Sculptor	0.419**	0.399**	0.418**
Drawer	0.493	0.475	0.528
Painter	0.377***	0.346**	0.355**
Degree c.	0.084*		
Betweenness c.		0.001+	
Eigenvector c.			41.187+
N	203	203	203

Note: Significance: *** - 1%; ** - 5%; * - 10%; + - 15%
Source: Own calculation.

6. Results - Networking of women visual artists

In the final empirical part we explore the relationship between network centrality and productivity as compared between women and men. To this end, we construct a series of interaction variables, namely:

- *Age_woman*: interaction between variables Age and Woman;

- *Agesq_woman*: interaction between variables Age squared and Woman;
- *20Cent_woman*: interaction between variables Born 20 Century and Woman;
- *MultRol_woman*: interaction between variables Multiple Roles and Woman;
- *Illustr_woman*: interaction between variables Illustr and Woman;
- *Sculptor_woman*: interaction between variables Sculptor and Woman;
- *Drawer_woman*: interaction between variables Drawer and Woman;
- *Paint_woman:* interaction between variables Paint and Woman;
- *Degree_woman*: interaction between variables Degree and Woman;
- *Between_woman*: interaction between variables Between and Woman;
- *Eigenvec_woman*: interaction between variables Eigenvec and Woman.

In Table 6 we present results of six models, namely, for each type of centrality we present results of modelling when including only the interaction variable for women and network centrality (the "reduced" model) and when including all interaction variables (the "full" model, controlling, therefore, for the differences between men and women in all observed characteristics).

The coefficients of our main interest are highlighted in grey. As for the degree centrality, the coefficient on interaction effect is insignificant in the "reduced" model while being positive and strongly significant in the "full" model. As for the betweenness centrality, the coefficient on interaction effect is negative – and strongly significant – in the "reduced" and positive and strongly significant in the "full" model. Finally, for the eigenvector centrality, the coefficient on interaction effect is positive and strongly significant in both models.

Therefore, although the evidence is not fully uniform (in particular for the betweenness centrality), it shows that women tend to have a stronger interaction, i.e. networking effect than men and therefore tend to use their network central position to improve their productivity much more intensely than men.

To our interpretation, three main elements related to women better positioning in the network may explain this effect:

- The better positioned women were also the most talented and/or productive ones, in particular due to selectivity effect, as women were clearly deprivileged to men and underrepresented in artist history throughout 20th and, in particular, 19th century;
- Better positions in networks provide women with more „boost" to their productivity, due to some of their inherent characteristics as compared to men;
- Selective, sampling bias: the women, included in our analysis were already the most productive ones *per se*, as in our sample we included only the ones with biographies in the web encyclopedia *Slovenska biografija* – a lot of women who performed artistic activities in history are not recorded in the database either due to the lack of data either to their low esteem in the artistic history.

Although all three interpretations seem likely, we would opt for the first one, which connects to the historical role of women visual artist the best and provides some nice fit to the existing literature in art history. Nevertheless, we hope that verifications in later research could provide a better-grounded and final answer to this observation.

Table 6: Results of econometric modelling (Poisson models), women effects

	Coef	Z	P>|z|	Coef	Z	P>|z|	Coef	Z	P>|z|	Coef	Z	P>|z|	Coef	Z	P>|z|	Coef	Z	P>|z|
Constant	4.6868	93.69	***	4.6874	89.84	***	5.1133	103.77	***	5.1096	99.23	***	3.9459	76.67	***	3.9742	74.25	***

Woman	-0.1189	-8.68	***	2.2328	20.03	***	-0.1773	-14.68	***	1.1594	7.13	***	-0.3054	-21.22	***	-0.3657	-4.60	***
Age	0.0157	10.64	***	0.0169	11.05	***	0.0115	7.97	***	0.0123	8.21	***	0.0404	26.97	***	0.0401	25.81	***
Agesq	-0.0001	-9.94	***	-0.0001	-10.77	***	-0.0001	-7.36	***	-0.0001	-8.04	***	-0.0003	-23.99	***	-0.0003	-22.92	***
Born 20 Century	0.2145	28.52	***	0.1792	22.53	***	0.2643	34.44	***	0.2351	28.98	***	0.3809	48.10	***	0.3536	42.04	***
Multiple Roles	0.0486	10.72	***	0.1020	20.93	***	0.0558	12.17	***	0.0961	19.50	***	0.0871	20.29	***	0.1008	20.31	***
Illustr	0.2314	10.49	***	0.0727	2.90	***	0.2566	11.66	***	0.1370	5.48	***	0.2624	11.94	***	0.1904	7.60	***
Sculptor	0.2460	13.73	***	0.2282	11.98	***	0.2541	14.17	***	0.2415	12.64	***	0.3627	20.34	***	0.3461	18.28	***
Drawer	0.5462	22.64	***	0.6096	24.45	***	0.6724	27.97	***	0.7800	31.32	***	0.6326	26.31	***	0.7516	30.18	***
Paint	0.3477	21.46	***	0.3327	19.12	***	0.3394	20.97	***	0.3371	19.32	***	0.2845	17.52	***	0.2871	16.48	***
Age_woman				-0.0902	-20.30	***				-0.0268	-5.55	***				0.0076	2.20	**
Agesq_woman				0.0006	19.41	***				0.0002	5.34	***				-0.0001	-2.37	**
20Cent_woman				-0.2433	-7.13	***				-0.3057	-7.93	***				0.0316	0.96	
MultRol_woman				-0.1047	-6.28	***				-0.1970	-12.14	***				-0.0222	-1.28	
Illustr_woman				0.7075	11.89	***				0.4305	7.46	***				0.1337	2.28	**
Sculptor_woman				0.4843	7.47	***				0.5857	8.90	***				0.4419	6.60	***
Drawer_woman				-1.7119	-12.61	***				-2.2894	-16.75	***				-2.1237	-15.73	***
Paint_woman				-0.0191	-0.32					-0.4437	-7.17	***				-0.1895	-3.14	***
Degree	0.1261	174.90	**	0.1249	172.41	***												
Degree_woman	-0.0026	-1.15		0.2409	27.28	***												
Between							0.0006	152.46	***	0.0006	150.63	***						
Between_woman							-0.0001	-11.19	***	0.0006	10.26	***						
Eigenvec													55.9211	172.73	***	55.3653	169.21	***
Eigenvec_woman													16.5685	10.24	***	19.9359	6.51	***
N	203			203			203			203			203			203		
LR test	29785.4	***		31586.3	***		21683.3	***		23008.1	***		21683.3	***		28490.8	***	
Log Likelihood	-18024			-17124			-22076			-21413			-22076			-18672		
Pseudo R-square	0.4524			0.4798			0.3294			0.3495			0.3294			0.4328		

Note: Significance: *** - 1%; ** - 5%; * - 10%
Source: Own calculation.

7. Discussion and Conclusion

In this article, we analyze the social networking of Slovenian women artists in the 19th and 20th century. To contextualize our analysis firstly, we present a theoretical overview of groups of Slovenian visual artists. We identify some initial groupings, with the predominant role of the impressionist movement at the end of the 19th century with several key figures.

Secondly, our analysis provided evidence to the existing clusters of artists commonly accepted in the Slovenian art history: we demonstrated the existence of six key "empirical" groups of artists throughout the 19th and 20th century (which confirms the hypothesis H1): The Impressionists; The Modernists; The "Vesnans"; The Old Masters; The "Sculptors"; The Layer's workshop. Moreover, we point to its key central figures, carrying the representatives of all six groups, with slight difference concerning the measure of centrality under consideration.

Thirdly, we estimate the effect of network centrality on artistic productivity, using a newly chosen instrumental variable to take into account the endogeneity in the model. We confirm the positive effect of network centrality on artistic productivity, yet with a significantly lower effect in significance as pointed out by some of the current literature. This serves as confirmation of hypothesis H2.

We also study the effects of confounding covariates, and found the negative effect for women, positive for age, positive for the 20th century birth occurrence and positive for several of the chosen occupations, which confirms hypothesis H3.

Finally, we verify a stronger relationship between network centrality and productivity for women as compared to men artists and provided some possible explanations, opting for the one that shows that the better positioned women were also the most talented/productive ones, in particular as women were clearly deprivileged to men in artist history throughout 20th and, in particular, 19th century. This confirms also hypothesis H4.

Although the innovative aspects of the approach adopted, some limitations and questions for future researches – using the same dataset – can be presented. One obvious limitation is in the sample size and selection. Not only are we limited in the possibilities of the web-based database *Slovenska biografija*, there is a real possibility of selection bias as well. The artists selected and published on the website of course represent only a small minority of the artists throughout Slovenian art history. The conclusions in our article, therefore, cannot hold in general without verification on a comprehensive dataset of all artists: the successful and well known's as well as the less successful ones. Although we do not expect the main direction of the findings could change, there could be changes in the size and significance of the findings. Furthermore, we do not take into account the "spillovers" across sectors. Although the database of *Slovenska biografija* allows a rich perspective on networking across multiple disciplines, not just across the arts but across all other fields of the society, we did not analyze the sectorial spillovers which is another still open question in the literature waiting for a proper study and approach.

Additionally, the network relationships between artists are of binary nature – either they are/have been connected through history or not. One could speculate that differences could be observed whether the relationships were due to family ties (marital status or blood ties), education and/or later career. It would be very interesting to model this heterogeneity in the type of relationship in the analysis as well. Additionally, no specific analysis has been developed to study the cross networking to check the impact of Slovenian artists at international level. This could be useful to understand the centrality and relevance of the Slovenian artists within the international artistic community and how they increase or decrease their social and artistic visibility. As the art history tells us (a good example is represented by Arte Povera), sometimes artists, misunderstood or not properly or fully recognized in their own country may be recognized first at international level. This clearly implies a non-linear trajectory in their artistic career (Besana, 2002).

Finally, the dataset could be extended in multiple other ways. We could include the data from other (printed or digital at international level) encyclopedias, which would surely complement and enrich our dataset significantly. As other potential extension, we could include also the artists from previous centuries, which are not supported by sufficient data in the current web-based database using different sources. Finally, additional information may be collected from the museums and galleries' archives, which provide useful information on their exhibitions, cooperating artists, performance, etc. throughout history. We plan to collect such kind of information and extend our database on a larger scale using the archive of one of the main Slovenian galleries. Here, clearly lies another important pathway of future research. We hope that the approach, developed in this article, will provide an adequate foundation for such endeavors in future.

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