Fame as an Illusion of Creativity: Evidence from Pioneers of Abstract Art

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ABSTRACT

We disentangle two social structural views of fame: whether social structure influences fame directly or through the mechanism of creativity. We test these views in a significant empirical context: 90 pioneers of the early 20th century (1910–25) abstract art movement. Across two different types of ties, we find that social structure shapes fame directly rather than through the mechanism of enhanced creativity. Within the social structure of informal ties, an artist with greater structural and compositional diversity among her peers is likely to be more famous. Within the social structure of co-exhibition ties, an artist who is a part of a tight-knit clique is likely to be more famous. Across both types of ties, the effect of social structure is not associated with the artist's creativity, which we measured using expert evaluations and a deep learning tool from computer vision. Rather, we argue that an artist with more nationally diverse peers had a creative identity that garnered more fame.

INTRODUCTION

> "Not everyone can be famous. But much of our daily experience tells us that we should if we possibly can, because it is the best, perhaps the only, way *to be*." (Braudy 1997:6).

Fame is intrinsically valuable. Fame is a key metric of success for professionals in business, academia, politics and the arts. Fame shapes access to resources and augments returns on individual effort. For the start-up, fame means access to prominent investors and talented employees; for the scientist, fame can determine the distribution of grants, labs and tenure; for the artist, fame wins benefactors, collaborators and marquee dealers. Thus, fame is both a means to success as well as an end in itself.

We define fame as the extent of attention an individual receives in public discourse (Shor et al. 2015, Van de Rijt et al. 2013, Currid-Halkett 2010, Braudy 1997). Fame is the sheer volume of attention, irrespective of the valence of such attention. Such large-scale attention defines who is important in the broader culture (Shor et al. 2015). Within creative industries, the conceptualization of fame as broad cultural visibility beyond one's field can be found in work of scholars such as Lang & Lang (1988, p. 84-85). Table 1(a) in the Appendix lays out the distinction between fame and other forms of symbolic capital.

Fame is crucial for careers in creative markets. It increases the likelihood of entering the consideration set of resource providers. Famous innovators earn higher returns to economic capital for their creative output. Moreover, the large-scale attention associated with fame helps individual mobility across fields. For instance, famous film actors and musicians can capitalize on their fame to enter a range of other fields from politics to business. Relative to obscure innovators their famous counterparts exert a disproportionate influence on our understanding of categories. For instance, famous scientists are seen as the genius behind team-led inventions; famous musicians end up shaping audiences' understanding of music genres. Thus, understanding the drivers of fame is crucial for understanding the success and failure of innovators in creative labor markets.

What makes innovators in creative industries famous? Past work suggests two views. The first view is that social structure has a direct effect on a producer's fame. In this view, social structure enables the dissemination of a producer's fame - it spreads the word about her work rather than shaping its creativity (Perry-Smith and Manucci 2017; Aral and Walker 2014; Kovacs and Sharkey 2013, Becker 1982).

The second view draws on prior work on social structure as the driver of creativity (Sosa 2011; Lingo and O'Mahony 2010; Perry-Smith 2006; Lena 2006; Uzzi and Spiro 2005; Burt 2004; Hargadon 2003; Ruef 2002; Coleman 1988). Specifically, social structures can foster creativity by providing access to new ideas (Borgatti and Cross 2003; Granovetter 1973). Based on prior work we conceptualize creativity as the extent to which an output diverges from what's been done before (Soda and Bizzi 2012, Mainemelis 2010, Caves 2000, Mumford and Gustafson 1988). Creativity is a highly valued attribute in creative industries (Jones et al. 2016; Lampel et al. 2011, Godart et al. 2014, Caves 2000, Hirsch 1972). In such industries, creativity means "independence from the influence of others and the capacity to propose a differentiated and unique contribution" (Soda and Bizzi 2012, p.102). Creative output with these qualities is likely to stand out and garner attention across a range of fields including science (Guetzkow, Lamont and Mallard 2004), technology (Kaplan and Vakili 2015) and the arts (Simonton 1980). For instance, in his study of over 5000 classical musical compositions by eminent composers, Simonton found that the compositions with more original themes were likely to be more famous (Simonton 1980). Taken together, these arguments imply that social structure shapes an innovator's fame by shaping her creativity.

These two views reflect the debate over the role of social structure and objective properties of an innovator's output in shaping her success. Even scholars who acknowledge the role of social construction in markets point out that objective properties ought to play a role in a producer's success. According to Zuckerman (2012) "we recognize an objective basis for valuation, and we typically expect objective conditions to constrain social valuation" (Zuckerman 2012, p. 250).

Prior work has not attempted to disentangle these two perspectives. While prior work has acknowledged the importance of social structure (Leahey and Cain 2013; Jones 2010; Cattani & Ferriani 2008; Coleman 1988; Crane 1987; Becker 1982, 1976), it has either not explicitly measured creativity or largely relied on measures of creativity that are themselves socially constructed – i.e. these measures are more a proxy of an innovator's social structure than her objective creativity (for exceptions see Kaplan and Vakili (2015) and Soda and Bizzi (2012)). Recent theoretical work points to the importance of distinguishing the role of social structures in promoting and developing creative output (Perry-Smith and Manucci 2017). However, we lack clear empirical evidence for the extent to which social structure fames directly or through creativity. Our study combines social structural data from a unique creative context with two complementary measures of creativity to examine whether social structure shapes fame directly or through the mechanism of enhanced creativity.

The two views in our theoretical framework have different implications of our understanding of how creative markets value the very talent that they idealize (Zuckerman 2012; Abbott 2001; Abbott 1998). If creativity is the link between social structure and fame, then it affirms that attaining fame is about being in a conducive social structure which fosters an innovator's creativity which, in turn, garners audience attention. It implies a direct link from production to reception of creative output. Under this view creative markets function relatively effectively in recognizing objective merit and rewarding it with attention. However, the absence of creativity as a link between social structure and fame would imply that even though such markets valorize creativity as a key form of merit, they might fail to recognize it.

We examine the implications of social structure for fame in the context of the emergence of the early 20th century abstract art movement. The emergence of abstraction during 1910-25 marked a radical departure from the representational art paradigm and ushered in numerous artistic innovations in modern art. We examine the relationship between the fame and the social structure of 90 artists from Europe and the U.S. who were among the pioneers of abstraction. We use data on two types of social structures – informal ties based on friendships and institutional ties based on artists co-exhibiting their work. Our data on informal ties allows us a rare glimpse into the artists' connections to each other as friends and family. While data on such ties is harder to access than those gleaned from readily observable bibliometric or team production ties, recent work has highlighted the value of such informal ties among cultural producers in shaping their success (Leahy & Cain 2013). Qualitative accounts of visual artists' communities suggest that informal ties among artists are valuable for honing their creativity as well for garnering exposure (Greenfield 2006; Caves 2000; Moulin 1984). In order to empirically disentagle the role of social structure and creativity in shaping fame, we include two complementary measures of creativity: an expert measure of an artist's creativity and a computational measure of an artist's creativity that avails advances in deep learning.

We do not find statistical support for a positive relationship between an artist's creativity and fame. Neither the objective computational measure of creativity, nor the expert measure of creativity mediates the relationship between an artist's local network structure and her fame. However, we find several aspects of an artist's social structure to be associated with her fame. Within the social structure of informal ties, we find that an artist in a brokerage rather than a closure position is likely to subsequently become more famous. Furthermore, we find that compositional diversity (diversity among an ego's alters) increases an innovator's fame. Specifically, an artist with more nationally diverse alters is likely to be more famous. Within the social structure constituted by co-exhibition ties, we find that an artist in a closure position, i.e. who is member of a tight-knit clique is likely to be more famous. Thus, using two different types of social structure, we find that social structure shapes an artist's fame directly. We find no evidence for social structure shaping fame through the mechanism of creativity.

Our study makes several contributions. First, we highlight fame as an occupational outcome in markets for creative talent. Second, our theoretical framework combined with advances in machine learning, allows us to substantially advance the debate on the role of social construction vs. objective merit in shaping success in creative labor markets (Zuckerman 2012; Lang & Lang 1988; Becker 1982). By using both an expert measure of creativity and an objective measure of creativity, our study is the first to demonstrate that creativity is not the link between an innovator's immediate peer network and her fame. Our results indicate that markets that valorize creativity fail to reward it with attention. Given our context of art markets which prize creativity, this is a conservative test of the decoupling of creativity from success. In doing so, we contribute to recent work on the role of merit (Castilla and Ranganathan 2020; Porter, Keith and Woo 2018; Kim and King 2014)- in this case creativity- in shaping occupational success. We argue that social structure shapes an artist's fame by shaping how an artist's creativity is perceived and talked about. A rich and growing body of work has cautioned against a simplistic link between the production versus dissemination of creative output (Perry-Smith and Manucci 2017; Nathaus and Childress 2013; Lena 2012; Peterson and Anand 2004;). Our study advances this perspective by jointly modeling the role of an innovator's social structure and her objective creativity in shaping her fame. In doing so, it contributes to recent theoretical work that underscores the role social structures play in generating and promoting novel output (Perry-Smith and Manucci 2017). Moreover, our study extends prior research on the role of compositional diversity and creative success (Aggarwal & Woolley 2019; Perry-Smith and Shalley 2014), much of which has focused on teams within organizations or in laboratory settings. We illuminate how compositional diversity shapes the success of innovators in boundarlyless markets (Arthur and Rousseau 2001, Tolbert 2001) which pervade our economy. Finally, in line with recent calls to avail advances in deep learning methods to advance theory and empirics (Choudhury et al. 2019), our approach represents a rich application of deep learning methods to refine our theoretical view of social structure and creativity of innovators.

SOCIAL STRUCTURE AND FAME

Our conceptual focus is on an innovator's social structure, specifically the extent to which she spans diverse or similar social words (Simmel 2010). We use social networks as a tool to model an innovator's social structure by the structure and composition of her peer network, which comprises innovators who know each other through personal and instituional relationships. Each innovator's immediate set of peers, her alters, constitute her local network, which is a source of ideas (Burt 2004) and social support (Reagans and McEvily 2003; Coleman, 1988). Such relationships with peers are crucial for bringing creative ideas to fruition (Kleinbaum & Tushman 2007) and garnering career opportunities (Ody-Brasier and Fernandez-Mateo 2017, Caves 2000). We operationalize the extent to which an innovator spans diverse social worlds with two measures - firstly with measures of structural diversity i.e. brokerage and closure, and secondly with measures of compositional diversity. When many of an innovator's alters are disconnected, we say she is a broker, or is in a brokerage position (Burt 2009). The disconnected alters of a broker represent diverse social worlds (Simmel 2010). In contrast, when an innovator has fewer disconnected alters, we say she is in a closure position. An ego in a closure position is connected to alters whose social worlds overlap. We operationalize compositional diversity of the local network with measures of diversity among alters' backgrounds.

As summarized in Table 2(a) in the Appendix, while prior work in creative industries has examined the link between social structure and various forms of symbolic capital, much of it has focused on the dyadic level (for an exception see Cattani, Ferriani & Allison 2014) on the role of associations to other individuals as a measure of social structure and on industry specific attention as a measure of symbolic capital. Importantly, none of them have empirically tested whether social structure shapes fame through creativity or independent of it.

In the following section, we develop two perspectives on how social structure shapes fame. One perspective is that social structure shapes an innovator's fame by influencing her creativity. An alternate perspective is that fame is socially constructed, whereby social structure directly shapes an innovator's fame independent of her creativity.

Social Structure as a Dissemination Channel

Prior work has recognized that an innovator's social structure can shape the reception of her creative output (Kovacs & Sharkey 2013; Phillips 2011; Obstfeld 2005; Fine 2003). Specifically an innovator's social structure can shape the reception of creative output, by influencing if and how much audiences hear about the innovator and her work (Aral and Walker 2014).

In its most direct form, social structure can shape an innovator's fame through word-of-mouth channels and access to promotional opportunities. Word about an innovator's work often spreads through her peers who know about her work and have seen it develop. Qualitative studies of visual artists' communities across different time periods and regions document that new artists' peers are often the first and most crucial channel ("or filter") that others rely on to learn about these artists (Caves 2000, pg. 28). The extent to which these peers form part of diverse or overlapping social worlds can shape a producer's fame. A brokerage position among peers can improve an innovator's access to promotional opportunities. Social structures that propagate an innovator's name and provide her channels to new audiences are likely to increase her fame. And, if we think of the spreading of fame as a multi-step diffusion process, we can imagine the name of an ego diffusing from her to her alters and from her alters to people beyond her local network. The more an ego's peers are disconnected from each other, the greater is the likelihood of her name diffusing to a disparate and hence a larger group of people. In contrast, the name of an ego in a dense local network might circulate repeatedly within her clique of peers and have a lower chance of diffusing beyond the local network.

Compositional diversity, that is, diversity in the types of people that make up an ego's network can help diffuse an innovator's name widely. Socially diverse alters constitute audiences from distinct sub-domains. As such they represent distinct opportunities for an ego to spread her name among a disparate and hence a broader range of audience. Moreover, access to diverse information can help an innovator learn about more opportunities to showcase her work to different audiences.

On balance we expect an innovator spanning diverse social worlds to have wider exposure. At the same time, within a field an innovator can benefit from being part of a cohesive close-knit clique. The shared vision and meaning prevalent in such cohesive cliques can help in the dissemination of an innovator's name and work. The trust, coordination and support associated with closure positions can help an innovator secure high-profile promotional opportunities. For instance, researchers working in a common field can leverage their network to assemble high-profile conferences, workshops and symposia with their peers. Such promotional opportunities, showcasing the work of an innovator and her like-minded peers, can help give an innovator's work a coherent identity and legitimacy within her field. To the extent such legitimacy helps spread an innovator's name, we can expect, a greater degree of closure within an innovator's circle of peers can help her fame.

Social Structure Shapes Fame Through Creativity

A long-standing line of research has examined the role of social structure and creative success (Sosa 2011;Fleming, Mingo and Chen 2007; Perry-Smith 2006; Burt 2004; Collins 2000). This literature has argued that innovator's who span diverse social worlds are more likely to be creative and, hence, successful (Soda and Bizzi 2012; Burt 2004). Both structural diversity (i.e. brokerage) and compositional diversity can augment an innovator's creativity and hence her fame. A broker can access non-redundant and diverse ideas through her disconnected alters. Non-redundant ideas offer opportunities for novel recombination of ideas resulting in creative breakthroughs (Fleming, Mingo and Chen 2007; Perry-Smith 2006). A broker can translate and transfer ideas between disconnected alters, moving ideas from one context, in which they are familiar, to another context, in which they might be seen as novel and creative (Burt 2004). Furthermore, a broker with a sparse local network faces less pressure to conform to norms prevalent among her peers (Bienenstock, Bonacich, and Oliver 1990), allowing the broker to experiment with new ideas and hence be more creative.

Compostional diversity can also spur an innovator's creativity(Aggarwal & Woolley 2019; Ruef 2002; Campbell, Marsden and Hurlbert 1986). Like structural diversity, compositional diversity can increase the likelihood of an ego accessing novel ideas (Chua 2018; Perry-Smith and Shalley 2014; Reagans and Zuckerman 2001). Past work has described producers with ties to alters with diverse backgrounds as a "cosmopolitans" (Gouldner (1958, 1957)). Such cosmopolitanism can stem from ties to others from diverse disciplines, media, nationality etc. Cosmopolitans have access to multiple social contexts—countries, organizations, industries, disciplines—which vary in cultural and institutional schemas, opportunities and processes. Access to diverse social realms exposes an ego to a wider range of novel ideas and practices (Campbell, et al. 1986; Constant, Sproull, and Kiesler 1996; Reagans and Zuckerman 2001). Such individuals are more likely to challenge and subvert traditional practices (Godart et al. 2014) and bring novel ideas and practices into a community (O'Mahony and Bechky 2008; Zou and Ingram 2013). This in turn can not only spur an ego's creativity but also help her create work that may appeal to a wider range of audiences (Godart et al. 2014).

Thus, both structural and compositional diversity facilitate the ability to create work that is new and deviates from what's been already done. Creative industries prize such creativity (Dewett & Williams 2007). The imperative for myriad innovators, from television writers to scientists, is to create work that breaks from existing coventions and embodies new ideas (Soda and Bizzi 2012). These qualities are crucial for eliciting and sustaining the attention for audiences across a range of indutries from culinary (Johnston & Baumann 2007) to video games (De Vaan, Stark & Vedres 2015) to nanotechnology (Kaplan & Vakili 2015). By breaking from existing models and coventions, innovators set themselves apart and garner attention (Dewett & Williams 2007). Based on these arguments, we expect social structure to shape an shape an innovator's fame by augmenting their creativity. Specifically, innovators who span diverse social worlds have an advantage in being more creative and, hence, more famous.

Our theoretical discussion presents two contrasting views of creative markets: one view presents a socially constructed view of fame where social structure shapes fame independent of an innovator's objective creativity. The other view argues that an innovator's objective creativity, even when emerging from her social structure, matters in shaping her fame. The two views are at the heart of past debates about social construction of success in creative markets. A key theoretical element of a purely socially constructed view of fame is that an innovator occupying a conducive social structure can become famous through greater dissemination opportunities and legitimacy independent of her objective creative merit. Absent a conducive social structure, more creative producers' works might never enter audiences' consideration set while less creative producers' works are promoted and attended to. Put another way, among two equally creative producers, their respective social structures can determine who ends up entering and remaining in audiences' consideration set. While stark, this view has been at the heart of scholarly debate (Sgourev & Althuizen 2017; Zuckerman 2012; Salganick, Dodds & Watts 2006) that we address by explicitly modeling the role of objective creativity in shaping fame.We disentangle these two contrasting views in our unique empirical context of the early 20th century modern art market.

EMPIRICAL CONTEXT

We examine a set of artists from Europe and the U.S. who were at the forefront of the abstract art movement that began around 1910. Until then, representational art had dominated the Western fine art world. A critical criterion for evaluating a work of representational art was how accurately it depicted the real world. This began to change in the 1900s with the advent of abstraction which represented a radical departure from the aesthetic of representational art. The new aesthetic paradigm encompassed several innovations in artistic style. These artistic innovations were contested like many innovations in art, science and technology and yet these became the foundation for much of modern and contemporary art. Examining the determinants of fame of these innovators gives us an opportunity to understand the factors that shape society's attention to individuals who radically changed their field.

The pioneers of abstraction came from several European and American cities and worked in several different styles and media. For instance, *Fountain*, an inverted urinal by French Dada artist Marcel Duchamp, destabilized the very idea of what constitutes art. Another pioneer of abstraction, the Russian artist Kazimir Malevich created "a new pictorial language of geometric shapes" (Chlenova 2012, p. 206) with his Suprematist paintings exemplified by a black square against a white background.

Past accounts of the emergence of abstraction have often portrayed these pioneers' work as a result of individual genius and solitary epiphanies (Dickerman and Affron 2012, p. 18). Yet, these artists did not work in isolation, and the development of their paradigm was much more of a collective process than is generally acknowledged. They were connected to each other as collaborators, friends, advisors, patrons, lovers and relatives. They exchanged ideas, promoted each other's work and exhibited at salons and galleries together (Dickerman and Affron 2012). For instance, the friendship between Marcel Duchamp, Francis Picabia and Man Ray began during this period and endured over four decades. During this period "they shared ideas and experiences, and socialized with each other and each other's partners as close friends. They played chess endlessly, and even holidayed together. They discussed what they were working on, and when apart kept in touch by letter. They exhibited together and helped each other with sales, commissions and contacts" (Mundy 2008, p.11).

This context offers several advantages for our study. Creativity is the key meritorious attribute in the art world. Breaking from conventions defines authentic art (Rader 1958). Creativity i.e. breaking from the past is a particularly cherished quality in abstract art which was defined by its rejection of 400 years of western pictorial tradition (Dickerman and Affron 2012). As such we would expect the artists' who deviated more from the existing traditions were likely to garner more attention.Unlike other creative contexts such as science, music, films etc., our context also allows us to systematically examine how peer relationships facilitate individual level creative output, rather than team output, thus allowing us to isolate the link between social structure, individual-level creativity and fame. The artists are akin to innovators like entrepreneurs and software developers whose locus of inventive activity transcends well-defined organizational boundaries (Gruber, Harnhoff, Hoisl 2013; Powell, Koput, Smith-Doerr 1996; Allen 1977). Our context allows us to study the social structure of such innovators, whose informal social structure is often empirically elusive but whose contributions continue to transform our economy and society. Finally, our context of an art market does not stack-the-deck for particular social-structural configurations, in that it allows for potential advantages of both brokerage and closure. On the one hand, being part of a diverse set of peers increases an innovator's access to the breadth of ideas and opportunities (Burt 2009; Giuffre 1999); on the other hand, in the notoriously cliquish art world, belonging to a close-knit group gives access to high profile promotion opportunities as well as to the social support needed to bring ideas to fruition (Coleman 1988).

We begin our empirical analysis with an example from our empirical context. The two artists in Figure 2 made important contributions to the early 20th century abstract art movement. Both are women, both were educated at elite art schools in their respective countries. Vanessa Bell attended the Royal Academy of Arts in England while Suzanne Duchamp attended École des Beaux-Arts in France. Both were also part of elite cultural families. Bell's father was the eminent literary critic Sir Leslie Stephen and her sister was the writer Virginia Wolf. Suzanne Duchamp was the sister of the iconoclastic Dada artist, Marcel Duchamp. Both artists married other established artists. Our survey of art experts shows both artists to be equally creative (we provide further details of our survey in *Creativity* subsection under *Data*). Yet figure 3 reveals these creative contemporaries to differ substantially in their fame as measured by mentions in texts in the Google N-gram corpus (we provide further details on our fame measure in the *Data* section)[1]. Moreover, in contrast to prior work on recognition (Williamson 1991), our example illustrates that the difference between the artists' fame is not simply the result of ties to powerful or high-status peers. Both artists were connected to powerful players in the art market. In fact, the difference is more surprising given that Marcel Duchamp was a star of the United States (U.S.) art market after the New York armory show in 1913. Despite her strong ties to such a high-status artist, Suzanne Duchamp received little attention in the texts published in the United States in that period. How can we account for observed variation in fame of these artists? In the following section we present our quantitative analysis to disentangle the role of these artists' social structure and creativity in shaping their fame.

We focus our analysis on the period 1910-25, which represents the key period for the emergence of abstraction (Dickerman and Affron 2012).

Insert Figures 3 and 4 about here

[1] We find a similar pattern for mentions in the German and Italian corpus. In fact, coming from France, the center of the modern art world in the early 20th century, Suzanne Duchamp was more likely to be seen as higher status than Bell who was English. Despite this, Duchamp is less famous than Bell.

DATA

Our empirical analysis draws on several sources of data. First, in collaboration with the curatorial division of the Museum of Modern Art (MoMA), we identified the connections between 90 artists who were at the forefront of the abstraction (Figure 4). Specifically,a team[2] of nine members of MoMA's curatorial and design division relied on MoMA's unrivaled collection of primary and secondary sources as well as those in the archives of museums across the world. (an abridged version of their sources is part of the supplementary appendix) to construct the network. The curators had selected the sample of artists independent of and well-before knowing the goals of our study. Their goal was to chronicle the invention of abstraction in the West for exhibition marking the centennial of abstraction. In preparation for the exhibition, over the course of eighteen months, the curatorial team researched an extenstive list of sources to construct a sample of artists who were instrumental to the development of abstraction in 1910-25, the focal period of emergence of abstraction. In order to identify these pioneers, the curators restricted their search to Western artists who defined their artistic practice as abstract in their writings and art works in 1910-25 (Cain 2017, Dickerman and Affron 2012). Crucially, the curators' selection process was not defined by the fame of the artists. Nor was it limited by the extent of published information about an artists. As experts, the curators have deep familiarity with the obscure yet important artistic figures and are also able to tap into specialized sources for information on such artists. As such their sample includes well-known artists as well as those who were pioneers of abtraction but have been excluded from published accounts of abstraction. For instance, the sample includes artists who are now famous such as Pablo Picasso as well as artists who are rarely included in historical accounts of early abstraction such as the Swiss

[2] The curatorial team comprised two lead curators, each a pre-eminent expert on abstraction as well as seven curatorial assistants. The teams members have deep expertise about abstraction, the artists' works and their social milieu through their doctoral training and experience as curators. In addition, the curatorial team worked with a group of specialists who are experts in their respective media - music, poetry, dance and literature.

artist Augusto Giacomettti and the Polish artist Waclaw Szpakowski. In order to find information on less well-known pioneers of abstraction, the curators relied on specialized literature, unpublished accounts in archives and other experts who were part of an external team specializing in abstract art across different media and countries. For instance, little published information exists about the Polish artist Szpakowski who was part of their sample. Yet, he was included in our sample. In order to learn about him, the lead curators reached out to Museum Sztuki in Lodz, Poland to interview scholars of avante-garde Polish art during this period. These steps resulted in a sample of artists who are considered by the experts as among the key pioneers of abstraction. The exhibition itself won several awards. Importantly, curators did not select artists on our dependent variable, fame. This is confimed by the distribution of artist's fame where most artists had no fame in 1926 (Figure 8) .

The curators defined an informal tie between two artists as knowing each other through a personal relationship. Two artists were deemed to have a tie if they had met in person or had exchanged correspondence during 1910-25. As before the curatorial team relied on an extensive set of primary and secondary sources to document these ties. These included chronologies in monographs, exhibition catalogs on individual artists, texts on abstract art movements and a close reading of specialized primary and secondary texts. The curatorial team verified the accuracy of connections through successive corroboration steps. Specifically, seven curatorial team members first combed through the sources and documented a tie. These ties were then again verified by the two lead curators.

In addition to the data on informal peer ties, we constructed a time-varying network for a sub-sample of visual artists (we excluded artists working in other media such as poetry and dance) who co-exhibited their work in Europe between 1910-16. Exhibitions are a key channel to promote an artist's work. Exhibitions were particularly crucial for the circulation and reception of abstract art and more broadly modern art in the early 20^{th} century (Brettell & Brettell 1999, Gordon 1974). According to Bretell, "It is largely through the regular practice of the international exhibitions and their artistic offshoots that the Euro-global world of modern art came to be defined (Brettell & Brettell 1999, p. 3)." We gathered data on the co-exhibition ties from Gordon's *Modern Art Exhibitions (1974)* which provides a list of exhibitions held in Europe between 1905-15 after which the record on exhibitions is sparse due to the onset of World War-I.

Our data on fame comes from the Google n-gram corpus which comprises over 8 million books which represent six percent of the books ever published.

In order to get an expert rating of the artists' creativity, we surveyed art-historians about the artists' creativity along five dimensions. For the objective measure of creativity, we collected images of the artists' paintings from ArtStor, a comprehensive database of images of visual art. Finally, we gathered data on a host of control variables for the artists through interviews with MoMA curators, *Oxford Art Online* and artists' biographies.

Dependent Variable

Our measure of fame is similar to past measures in that it is based on the mentions of names in a corpus (Shor et al. 2015; van Rijt et al. 2013). Instead of confining the corpus to those in a specific library (Martindale 1995) or industry journal (Giuffre 1999), we use the Google n-gram corpus. Past work has demonstrated the promise of this corpus in understanding the evolution of fame of artists (Michel et al. 2011). Using this much larger corpus allows us to measure the mentions of an innovator's name in a much larger "volume of public discourse" (van de Rijt et al. 2013, p. 267) thereby allowing us to better measure how widely an innovator is known. Moreover, since the corpus spans multiple languages, using this measure allows us to hold constant attributes of the innovators and their output while varying the features of the audience across two major but different art markets: France and the U.S.

In 1910-1926, France, was the center of the Western fine art world. It was the seat of art academies such as Academie des Beaux Arts (Kleiner 2013). Paris hosted numerous salon exhibitions that showcased artistic developments (Cottington 1998). Newspapers and art journals regularly featured these developments, which were actively debated by critics, dealers and collectors in salons and cafes (Gee 1977).

In contrast, United States was a peripheral market. It was relatively isolated from the developments in the art world (Gee 1977). Unlike France with its institutionalized system of salons, the United States was introduced to abstract artists ad hoc, as they happened to be discovered by individual patrons and artists, each of whom learned about abstract art through diverse channels and experiences (Martinez 1993).

We measure each artist's fame in this corpus by the mentions of her name which typically corresponds to a 2-gram (e.g. Fernand Leger) or a 3-gram (e.g. Morton Livingston Schamberg). The measure is standardized for the size of the corpus by dividing the count of an artist's name in the corpus by the number of 2-grams (or 3-grams) in the corpus[3]. We use a log-odds transformation of this fame measure, which is a proportion and follows a skewed distribution. Our results remain the same when we use the untransformed fame variable in a generalized linear model. We measure fame in 1926 (the year after our network measures were taken and year following 1910-25, the period that marked the emergence of abstraction (Dickerman and Affron 2012)) in the French and U.S. English corpus. In robustness checks of the durability of the effects we identify, we extended the measure of fame to the year 2000.

[3] Our measures of fame are based on the spellings of artists' names used by MoMA curators. We expect these spellings to be widely used in texts discussing these artists' work but many of the artists had alternate names. In order to account for other versions of the artists' names we re-ran our analysis using the sum the of fame measures of the alternate names specified in the Library of Congress Name Authority File (LCNAF) and J. Paul Getty Trust's Union List of Artists Names (ULAN) databases. Results were consistent with those reported here.

Face Validity of Our Fame Measure As Broad Cultural Visibility

In order to ensure that the nGram measure is in fact a good proxy for fame in the broader culture rather than a field, we examined correlations between the mentions in the n-Gram corpus and mainstream press. We find that artists' name mentions in the 1926 US n-Gram corpus has a correlation of 0.58 with those in *New York Times* in 1926. Similarly, we find that artists' mentions in the 1926 French nGram corpus has a correlation of 0.87 with those in *Le Matin* in 1926, a major French newspaper in the early 20th century. These strong correlations further validate the n-Gram measure as a proxy for fame.

Independent Variables

Local Network Measures

We use social network measures to operationalize the extent to which the artists spanned diverse social worlds. We compute these measures for two types of ties.

Insert Figure 4 about here

The first of these are informal ties (figure 4).The ties in our data were formed in the period 1910–1925, the period that mark the emergence of abstraction. We construct a static network that formed over 1910–25 since the data on the friendship ties does not vary over time.

We also computed time varying network measures for the network comprising instutional ties, specifically co-exhibition ties between the artists. Two artists have a tie in a given year, if they co-exhibited at an exhibition in that year. We computed network measures for each year from 1905 till 1916, after which the record on exhibitions is sparse due to the beginning of World War-I.

We operationalize our variable for structural diversity i.e. brokerage, by subtracting Burt's (2005) constraint measure of the ego network from one. We also controlled for degree centrality, which is a count of the number of network ties an artist has to other artists.

In order to operationalize our other key social structural variable, compositional diversity, we used data on artists' national backgrounds. We measured the diversity in an artist's alters' national affiliations by the index of qualitative variation used for categorical variables (Marsden 1987; Agresti and Agresti 1977). An artist is affiliated with a country if that country was her primary place of residence. The measure is calculated as a proportion of the actual distribution of alters across the countries and maximum possible distribution of alters across the countries. If all alters belong to one country, then the index is 0 in which case ego has no diversity in her local network (see Appendix 6a for formula). If each alter belongs to a different country then the index is 1 in which case ego has maximally diverse network. We called this measure *Alter National Diversity*.

Expert Measure of Creativity

We used two complementary measures to operationalize creativity, an expert evaluation and an objective computational measure of creativity which uses a convolutional neural net. For the measure based on expert evaluation, we asked art historians to rate the average creativity of each artist's work in 1910–25 along five dimensions: *originality* (the extent to which an artist breaks from known aesthetic precedent), *uniqueness* (the extent to which an artist's work was distinct, different or one-of-a-kind), *stylistic diversity* (the extent to which an artist worked in many different styles, media, technique etc.), *abstraction* (the extent to which an artist's work was non-figurative) and *innovativeness* (the extent to which an artist was among the first to come up with a new artistic style).[4] Experts were also asked to rate the overall quality of each artist's work in the 1910–25 period.

Raters were given the option to not rate an artist and briefly describe why they were not able to do so. Each creativity dimension in our survey varies along a five point scale. Two independent raters rated each artist on all six dimensions. The inter-rater reliability score for the two raters' ratings measured by the inter-class coefficient (consistency) varied between 0.6 and 0.78. Factor analysis revealed that all six dimensions including quality load onto a single factor.

Computational Measure of Creativity

The computational measure of creativity is meant to capture the extent to which a piece of work differs from the representational paradigm that preceded the emergence of the abstract art movement. In order to calculate the measure we use a convolutional neural net, a deep learning tool that avails advances in computer sciences and statistics[5]. Recent work has begun to use similar computational methods to measure novelty reflected in the textual descriptions of creative output such as patents (Kaplan and Vakili 2014) and music (Askin and Mauskapuf 2017). Similarly these methods have yielded insights about cultural conformity (Goldberg et al. 2016) social deviance (Goldberg, Hannan and Kovaćs 2016) and informational density in languages (Aceves 2018). We used a machine-vision algorithm[6], developed by a team of computer scientists (Jia et al. 2014;

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[4] The qualities of originality and innovativeness are frequently invoked by art historians in style analyses (Csikszentmihalyi and Getzels 1971 Simonton 1980). Abstraction was a key stylistic innovation of the art works and is therefore included here. Stylistic diversity or eclecticism is another criterion that critics and dealers use to characterize an artist's oeuvre (Gee 1977). Finally, uniqueness is regarded as an important component of creativity in cultural markets (Caves 2000). Our interview with an art historian confirmed that our dimensions were in fact applicable to the artists' creativity.

[5] In the past experts have been used to create objective measures of creativity of output such as television scripts (Soda and Bizzi 2012). But the machine learning tools allow us to measure creatitivity of complex output at a large scale without introducing the inconsistencies of employing multiple experts.

[6]The machine-vision algorithm is based on Caffe ImageNet image recognition algorithm. The algorithm uses covolutional neural networks to learn representations of images. The algorithm was trained and refined on a set of 1,034,908 non-art images and then applied to the images in our data set. Further details included in table 3a the appendix.

Krizhevsky, Sutskever and Hinton 2012), to represent each painting as a 4096 dimensional vector of features. We use the convolutional neural net to *represent* each painting and not for the purposes of prediction. The input to the algorithm is an 224X 224 matrix of pixels where the pixels represent RGB values. The output is a 4096 dimensional vector representation of the image (for further details please see Appendix 3a). The algorithm was pre-trained on over a million non-art images. The training process did not introduce any information about the fame of the artists or their works. Since the algorithm is meant for images, we applied this algorithm to all the works of 74 visual artists (we excluded artists working in media such a poetry and sculpture) in our data (3478 works in all) as well as 2000 images of art works from the 19^{th} century representational paradigm.

Similar to prior work in creative industries (de Vaan, Stark and Vedres 2015; Askin and Mauskaupf 2017) we employed a cosine distance based measure to capture how different a focal work is from those in representational paradigm. For each work, we computed the cosine distance between its feature vector and the feature vector of each of 19^{th} century pieces of art in the data (our results remain similar when we compute the creativity of the artists' works using alternate reference windows from 1900-25). Thereafter, we took the average of the cosine distances of a focal work of art from all the 19^{th} century works of art. The greater this distance for a focal work of art, the more novel it is. The computational creativity score for each artist in a given year is the average of the creativity measure for all her works created till that year.

Our computational measure captures our conceptualization of creativity as evidenced by the face validity of our measure. For instance, the average cosine distance of the painter Vasily Kandinsky's painting, *The Birds from Xylographies,* is 0.801. In contrast, the average cosine distance of his more abstract painting, *Several Circles,* is 0.869 (see Figure 5). Since abstraction was a new movement and differed more from the representational paradigm, this example indicates that our measure is capturing the greater creativity of the more abstract piece. Our measure is also able to identify differences in creativity between artists. For instance, based on our measure, Pablo Picasso is ranked among the two most creative painters in 1920. Yet, the Czech artist Frantisek Kupka was ranked as more creative than Picasso. Kupka was among the pioneers of abstraction but has largely been overlooked. His work such as the Amorpha (Figure 6a), painted in 1912, represented, "a complete break from representational painting" (Cain 2017, Dickerman and Affron 2012). Relative to Kupka, Picasso's abstract works, as reflected in figure 6b, still comprised figurative elements in them. The fact that our computational measure is able to identify Kupka as more creative than Picasso gives us further confidence in its face validity. Moreover, this example also illustrates that our computaitonal measure of creativity is not biased by the fame of the artists. As further evidence of the validity of our computational measure, we find a statistically significant and positive correlation between and expert measures of creativity. The correlation is larger than but similar to the correlation of 0.22 that Kaplan & Vakili (2015) find for their machine learning measure of nanotechnology patents' novelty and nanotechnology experts' measure of novelty. The correlations in our study are high, when we take into account our sample size and the completely different methods used for our computational and expert measures of creativity.

Figure 7 (a) plots the relationship between the expert measure of an artist's creativity and her fame in 1926 while Figure 7 (b) plots the relationship between the computational measure of an artist's creativity in 1925 and her fame in 1926. In both figures, we observe artists varying in their creativity but having similar levels of fame. Despite a weak positive correlation, neither measure of creativity can fully account for the variations in fame.

Insert Figure 5, 6 and 7 about here

Control Variables

We included several artist-level control variables. The data for these variables comes from the MoMA, artists' biographies, Oxford Art online and the Ngram corpus. The variables include age in 1926 (*Age1926*), gender (*Female*), fame in the U.S. and France in the year our observation begins, 1910 (*USFrFame1910*), number of media an artist worked in (*No. of Media*), number of countries an artist worked and lived in (*No. of Countries*), number of art movements an artist belonged to between 1910-25 (*No. of Movements*), the primary media an artist worked in (*Primary Media*), the primary art movement or school an artist belonged to during 1910–25 (*Primary Movement)* and the dummy variables for artists with French (*French*) and American (*American*) nationality. We also included a dummy variable for whether an artist died in the war (*Died in WWI)* since dying in war could have increased an artist's fame by making him a national hero or could have limited his fame by cutting short his artistic career.

The descriptive statistics and correlation matrix for the variables is included in Table 1. Figure 8 show the distribution of fame of the 90 artists. Most artists in the sample had no fame in 1926, further allaying concerns that the curators selected the artists on our dependent variable.

Insert Table 1 about here

Insert Figure 8 about here

ANALYSIS AND RESULTS

OLS Analysis

We begin with ordinary least squares (OLS) regression to estimate the relationship between social structural variables and the log-odds transformed fame variable. Alternate models which use the untransformed fame variable and a fractional logit model, a generalized linear model using quasi-likelihood technique, yield the same results.

Table 2 shows the OLS results for the combined fame in U.S. English and French in 1926 (Models1-5). Across all models, an artist's initial fame in 1910 is positive and significant. Model 1 is the baseline model with the control variables. Among these, age and American nationality are positive and significant. Model 2 introduces the variable for degree centrality for which the coefficient is not significant. This non-result is important as it rules out a possibility that the identification of artists' network ties by MoMA curators would be biased against less famous artists. The number of network relationships the curators identified for an artist was not significantly related to the artist's subsequent fame.

Model 3 introduces the brokerage measure, which is positive but not statistically significant.

Insert Table 2 about here

Model 4 includes alters' national diversity, which has a positive and significant coefficient. The brokerage measure, while positive is not statistically significant. It is worth noting that national diversity is significant even when controlling for an artist's nationality. This indicates that the benefits associated with cosmopolitanism accrue not only to immigrants because of their ability to adapt to a foreign culture but also to native artists.

In the full model (Model 5) we include the expert measure of the artist's creativity. Creativity was not significantly related to fame in any model (the sub-components of the expert creativity measure likewise do not have effects on an artists' fame). Again as in preceding models, alter national diversity is positive and significant, while the variable of brokerage is not statistically significant.

Sub-sample Analysis Using Computational Measure of Creativity

In table 3, we re-estimated our model using the more objective computational measure of creativity on the reduced sample of artists for which that measure is calculable. These models also include the variable for exhibition opportunities, thereby allowing us to also control for promotional opportunities. In Models 6 and 7, brokerage and alter national diversity are positive and significant. In Model 8 the measure of creativity is positive and but not significant. Model 9 shows that the number of exhibitions where an artist showed their work between 1910-16 is positive but not statistically significant. In the full model (Model 10), both our measures for social structure – brokerage and alter national diversity have a positive and statistically significant association with fame, even when we control for creativity and exhibition opportunities. The measure for creativity is not statistically significant. These results provide further support for the role of social structure directly shaping an innovator's fame. Moreover, the fact that national diversity remains significant, even after controlling for creativity, provides support for a socially constructed view of fame where an innovator's social structure shapes her fame independent of her creativity.

Insert Tables 3 & 4 about here

Difference-in-difference Analysis

Within the above sub-sample of 74 artists, we avail their peers' death in World War I as a treatment to the local network structure. The death of some artists' peers resulted in lower degree centrality and lower brokerage (or higher constraint). In our diff-in-diff analysis, artists who experienced a decrease in brokerage due to their peers' death comprise the treatment group, while the artist' who did not experience a loss of peers in the WWI comprise the control group. We use the 1914-1926 as the post-treatment period and 1910-13 as the pre-treatment period. We use a dynamic panel estimation method for this panel from 1910-26 to estimate the treatment effect of decreased brokerage. Table 4 (Model 11) shows a negative treatment effect (*Treatment Effect*) for artists whose local network became more dense due to a loss of peers. In other words, a decrease in brokerage i.e. structural diversity caused an artist's fame to decrease. Like the previous models, the computational measure of creativity remains insignificant. These results provide support for the causal role of structural diversity in increasing fame. They also provide further evidence for social structure directly driving fame and no evidence for social structure shaping fame through creativity.

Structural Equation Model

We further investigated the mechanisms linking social structure and fame with a structural equation model (SEM) on the sub-sample of 74 artists. For this analysis we are able to leverage our time varying measures of fame and computational measure of creativity, to explicitly test (a) the direct and indirect links between the independent variables and the dependent variable and (b) the links between prior creativity and fame on our social structural variables. Table 5 shows our results and Figure 9 gives a pictorial summary of our results. In model 12, we test whether brokerage and national diversity independently influence fame through creativity. We see that brokerage does not have a statistically significant relationship with creativity, measured with the computational measure of creativity. Alter national diversity has a positive and statistically significant relationship with creativity (see *Effects on Creativity* in Table 5). We also checked if either of the structural variables have a relationship with exhibition opportunities – brokerage has a positive and significant relationship with exhibition opportunities whereas there is no statistically significant association between alter national diversity and exhibition opportunities. However, similar to our OLS model, we did not find statistical support for either creativity or exhibition opportunities as the link between the social structural variables and fame.

In Model 13, we examined whether brokerage and national diversity have a direct link to fame even when we control for creativity and exhibition opportunities. Similar to prior analysis, we find that both measures of social structure, brokerage and alter national diversity, have a direct relationship to fame. We also tested for an association between the two structural variables, brokerage and alter national diversity. We find that neither variable is a statistically significant predictor of the other (see "*Effects on Brokerage*" and "*Effects on Alter National Diversity*" in Model 13, Table 5).

Our analysis also lets us examine whether an artist's prior fame and creativity before 1910 influenced their network position. Prior fame in 1909 (Models 12-13, Table 5) does not have a statistically significant association with the brokerage position ((see "*Effects on Brokerage*" and "*Effects on Alter National Diversity*" in Table 5). Moreover, an artist's computational creativity in 1909, while positive, is not statistically significant as a predictor of her brokerage position in the network.

Our analysis reveals that both structural and compositional diversity are positively associated with fame[7]. We do not find evidence for creativity as the link between our social structural variables and fame. In the discussion section, we elaborate on a social structural view of fame, where social structure shapes an innovator's fame by shaping the perception of her creativity.

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[7] In addition to the above analyses, we used boot-strap analysis to estimate the likelihood of finding our results by chance if the null hypothesis is true i.e. there's no relationship between structural/compositional diversity and fame. Our analysis using 5000 simulated data sets, found that the observed value of coefficients in our main results are likely to occur less than 5% of the time by chance across the 5000 boot-strapped samples (results available from authors), thus providing further support for the robustness of our main results.

Sub-Market Analyses

In order to further investigate the robustness of our results we decomposed our fame measure into two components: U.S. fame and French fame. As we explained, France in the time we studied was a central, and highly institutionalized art market, while the US was peripheral, with weakly developed institutions.

Table 4a in the appendix replicates the models in Table 2, with French fame and U.S. fame in 1926 as the dependent variables. In both France and the US, the results are in line with those in Table 2: brokerage has a positive (although not always statistically significant) effect on fame, alter national diversity has a positive effect on fame, and creativity is not associated with fame. These consistent results from two very different markets provide further confidence that the findings here are generalizable across art markets.

Fame Across Time

We undertook further analysis of fame at different points in time to confirm that our results accord with our conceptualization of fame as widespread public attention. In these analyses we found results consistent with those presented using the 1926 measure of fame: brokers and those with compositionally diverse i.e. nationally diverse networks were more likely to be more famous. Table 5a in the appendix shows the results for the dependent variable of combined fame in French and U.S. English in 2000 (results for other years are available from the authors). This provides further evidence that our measure of fame is distinct from measures like field specific visibility which is temporally limited.

Fame in Mainstream Press

In order to further validate that our results speak to fame as visibility in broader culture, we examined whether brokerage and compositional diversity are associated with mentions in mainstream press. Using artists' name mentions in two major newspapers in the US and France – *New York Times* and *Le Matin* in 1926 , we estimated a negative binomial count model (results remain the same with a poisson model specification). Once again, our results show that brokers and those with more compositionally diverse networks are more likely to get mentions in mainstream media (results available from authors).

Fixed Effects Analysis Using Exhibition Network

Next, we examined if social structure shapes fame directly or through creativity in the institional network constituted by the artist's co-exhibition ties . Using Gordon's *Modern Art Exhibitions (1974)* we constructed the exhibition networks for nine years (1905-1916) for 24 visual artists for whom this data was available. We combined the brokerage measures from these exhibition networks with the computational measure of the artists' creativity in a dynamic panel model. We included artist and year level fixed effects to control for any artist or year specific idtiosyncracies that might affect their fame. Our results provide further causal evidence for the role of social structure shaping fame directly. Like previous models, the computational measure of creativity is not significant (Table 6). Moreover, the coefficient of brokerage is negative and significant (Model 15, Table 6) . Thus, our results confirmed previous models' results wherein social structure directly shapes fame rather than through the mechanism of creativity. However, unlike the results from the artists' informal ties, we find that higher closure in the exhibition network results in greater fame. We discuss these results in the following section.

DISCUSSION AND CONCLUSION

What explains the fame of innovators? We found that it was not creativity *per se,* but rather the social structure in which an innovator is embedded. Let's return to the historical puzzle we introduced in our empirical context. Compositional diversity can account for the disparity in the fame of the two artists, Suzanne Duchamp and Vanessa Bell. Both artists were part of influential artists' groups – Suzanne Duchamp was part of the Dada circle while Vanessa Bell was part of the Bloomsbury group. Yet Duchamp's social circle was confined to the Dada artists. In fact, even within this circle, her closest friends were her brother Marcel, her husband Jean Crotti and the artist Francis Picabia, a family friend (Camfield 2001, p. 92). In contrast, Vanessa Bell's social world encompassed the Bloomsbury group, a broad swathe of artists who were part of the London Group as well as theatre innovators and artists associated with Sergei Diaghilev's *Les Ballet Russes* (Shone, Beechey, and Morphet 1999). The greater diversity of Bell's social world relative to Duchamp is reflected in their respective alter national diversity values. The national diversity within Bell's alters is 0.74 out of the maximum possible value of 1. This is seventeen percent higher than Duchamp's alter national diversity of 0.63. The diversity within Bell's peer network defined her cosmopolitan identity and provided access to a broader audience. In contrast, Suzanne Duchamp, while praised by critics, remained well known only within a homogenous circle of peers and relatives.

Our finding that neither the expert nor computational measures of creativity mediates the link between social structure and fame highlights the powerful role of social structure in shaping fame independent of creativity. The result is particularly striking given the importance of creativity in our context of the art market[8]. As such, our context provides conservative test for social structure directly shaping fame. We expect the direct effect of social structure to be even stronger in other contexts,

[8] Soda and Bizzi's (2012) argument for a negative relationship between project creativity and success focusses on the difficulties implementing creative ideas. Their study differs from ours which focusses on the creativity of the finished product.

where creativity is nearly not as valorized as it is the art market.These results imply a more nuanced way by which an innovator's social structure shapes her fame.

Social structure can influence an innovator's fame by shaping the perception of her creativity i.e. her creative identity. Such an identity can shape audience's understanding of her work (Rao, Monin and Durand 2003). Compositional diversity among an ego's alters shapes her identity, i.e. how she is perceived by others. Social identity theory argues that others evaluate an individual based on her ties to others (Lin, Prabhala & Viswanathan 2013;Brewer and Gardner 1996; Heider 1958). In this respect, a tie is seen as an affiliation and can inform how an audience interprets an individual's role and allegiances. In creative markets, such interpretations shape audiences' perception of an innovator's creative ability, thereby shaping her creative identity. Furthermore, a cosmopolitan is seen as an "outsider " (Gouldner 1958, p. 449-450; Gouldner, 1957, p.292) because of her ties to others outside the local community (Gouldner 1957) or the core of a field (Dahlander and Frederiksen 2012). As such, cosmopolitans are seen as open to new conventions and perspectives (Chua 2015). In effect, the outsider identity of such innovators might contribute to others' perception of them as rebels who are authentically creative (Fine 2003). Audiences may criticize such a challenging creative identity, but it is more likely to garner attention.

We looked for evidence of the artists' creative identities in representations of her work in public discourse (Glaveanu and Tannggaard 2014). Historical art criticism from the period reveals that cosmopolitanism and nationalism of an artist's milieu informed critics' evaluation of her creative identity. A cosmopolitan identity stemming from a diverse milieu was consonant with an artistic identity of creating art for art's sake and of estrangement from the "mainstream cultural apparatus" (Cottington 1998,p.132). In contrast, a nationalist identity was more consonant with an identity of belonging to the "establishment."

The creative identity associated with an artist with diverse national alters was consonant with an artistic identity of being outside and opposed to the traditional representational paradigm. Such an identity helped an artist's fame in two related ways. First, the creative identity associated with cosmopolitanism constituted a more authentic creative identity (Fine 2003), one that signaled the independence of an artist's vision, and one that was not circumscribed by allegiance to either a traditional paradigm or a nationalistic political agenda. Second, the creative identity of the cosmopolitan artist was congruent with the aesthetic preferences of audiences who viewed themselves as champions of an aesthetic credo which valued art for art's sake (Cottington 1998).

A cosmopolitan innovator's diverse background can result in audiences attributing multiple interpretations to her creative work (Padgett and Ansell 1993). In a creative context, the multiplicity of meanings can result in an innovator's work being seen as richer and full of creative possibilities (Collins 2000). The multiplicity of meanings and authenticity associated with a cosmopolitan innovator's work engages the attention of a wider audience, each of whom reads into an innovator's oeuvre a meaning that makes the work more personally resonant. Thus eliciting widespread attention requires a rich creative identity that balances the goal of authenticity with that of appealing to a wide range of audience tastes. Our study suggests that such an identity and the associated fame can arise out of the compositional diversity of an innovator's local network. This interpretation provides a fertile ground for future research which can further explore the role of network composition as a signal of legitimacy (Galaskiewicz 1985; Baum and Oliver 1991; Stuart, Hoang and Hybels 1999) as well as a rich creative identity. Such research stands to enrich our view of network compositional diversity by showing that diversity not only shapes informational advantages (Hoffman and Maier 1961; Gruenfeld et al. 1996; Mannix and Neale 2005) but also an identity which can be advantageous in creative contexts.

While past work has theorized about the role of structural and compositional diversity in facilitating creativity, it has operationalized creativity with measures of creative success rather than objective creativity. This has resulted in imprecise theorizing where its unclear whether social structures shapes actual creativity or the perception of creativity. Recent work has begun to highlight the importance of this distinction for understanding the role of merit in labor markets (Castilla and Ranganathan 2020; Porter, Keith and Woo 2018; Kim and King 2014 pg.2633-2634). By providing evidence that social structure shapes fame directly rather than through the mechanism of creativity, our study clarifies past theory. Crucially, our model and methods, provide a systematic framework that can be applied to other contexts to disentangle the role of social structure and creativity in shaping success.

Our results speak to prior work which has sought to disentangle how different types of social structures affect various aspects of creativity. Perry-Smith and Manucci (2017) theorized that brokerage helps the "active promotion of a novel idea" (Perry-Smith and Manucci 2017, p. 58) rather than the development of an idea. Our empirical result wherein brokerage directly helps the dissemination of an innovator's name rather than her objective creativity is consistent with their theoretical insight. At the same time, our results suggest further extensions of Perry-Smith and Manucci's (2017) theoretical arguments which focused on the promotion of an idea before it becomes a final product. Our results point to the differential role played by structural and compositional diversity in the creativity of the final product and the fame of the innovator once the final product enters the market. In our structural equation model (Table 5), we do not find evidence for brokerage being positively related to the objective creativity but we do find evidence for national diversity being positively related to creativity. This result suggests that brokerage can give access to novel opportunities to dissseminate one's work but not to shape the actual creativity of the work itself. Future research can examine the types of novel information that individuals in brokerage positions are able to benefit from i.e. information about career advancement versus information to create novel work.

Our theoretical review indicated some forces that argued in favor of an advantage of closure/homogeneity for garnering fame. We find evidence for this in the result from the exhibition network, where an artist in a closure position is likely to be more famous. Being part of close-knit clique within this institutional network helped an artist marhsall the support needed to gain attention and access to high profile promotional opportunities in the exhibition circuit. Thus, while cosmopolitanism is helpful within an artist's informal community, closure is helpful within her institutional community. Crucially, in both communities, social structure shapes fame directly rather than through the mechanism of creativity.

Our results have implications for the structure of creative labor markets. Being widely known can be seen as a two stage process (Zuckerman et al. 2003): in the first stage an innovator becomes recognized as a legitimate member of the field, and then in the second stage the innovator gains widespread attention. As the leading, but not most famous, innovators of the abstract art paradigm, the artists in our study can be regarded as top members within their field, and thus the second rather than the first stage of the model is more applicable. Our results imply that, within this set of pioneers of a field, creativity is not a differentiator. Future studies, which include less pioneering innovators can examine the first stage of the process, where we expect creativity to affect the likelihood of an innovator receiving the attention necessary for becoming a legitimate member of a field. Viewing fame as a two-stage process allow us see that our results do not contradict the well-established position that network brokerage is associated with creativity in other contexts. At the same time, paradigm shifts seem particularly fertile for the cultivation of fame, so the fact that brokerage was not associated with more creative output in our context is highly relevant to our goal of contributing to a structural theory of fame.

A scope condition for the positive effect of compositional diversity on fame is our context of a creative market where innovation is a key aspect. In this context, we argue that national affiliation as a salient driver of an innovator's identity. This is consistent with prior work which suggests geographic origins of innovators and their innovations might be a salient lens through which audiences understand and value these innovations (Phillips 2011, Godart et al. 2014). Moreover, other forms of cosmopolitanism, such as ties to peers outside one's field of specialization, also shape an individual's creative identity. In contexts where innovation is a key aspect, we can expect the cosmopolitan identity associated with compositional diversity to be interpreted positively. In non-innovation contexts, we remain agnostic about the benefits of a cosmopolitan identity.

Our arguments and propositions can be meaningfully extended to other non-innovation contexts such as the social structure and fame of CEOs, social activists, organizations and brand labels. For instance, future studies can examine whether a social activist who protests with peers from social movements with diverse platforms or protest tactics is more likely to attract broader media attention. Similarly, future studies can examine if founders of start-ups with ties to peers from diverse industries and countries is likely garner more widespread media attention.

CEOs, activists, scientists and innovators all benefit from fame. Meanwhile, the struggle for fame is becoming ever more intense and complex in a digital economy. This is particularly true of industries where actors experience high variance and mobility in their careers. Such variance and mobility characterize an increasing number of industries. As such, it is imperative to understand what factors shape fame. Our study sheds light on a pivotal factor, social structure, and the associated implications for an innovator's identity and creativity.

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Table 1
Descriptive Statistics & Correlations

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Age 1926	42.47	8.64	1.00																				
2. Female	0.14	0.35	-0.23	1.00																			
3. Combined Fame 1910	-45.43	19.12	0.33	-0.19	1.00																		
4. Combined Fame 1926	-33.17	19.53	0.34	-0.17	0.54	1.00																	
5. Combined Fame 2000	-20.16	9.87	0.32	-0.34	0.27	0.34	1.00																
6. US Fame 1926	-34.08	19.32	0.36	-0.16	0.55	0.98	0.33	1.00															
7. US Fame 1910	-47.00	18.33	0.32	-0.16	0.93	0.50	0.25	0.51	1.00														
8. French Fame 1926	-41.45	20.29	0.26	-0.19	0.49	0.69	0.35	0.65	0.42	1.00													
9. French Fame1910	-51.52	16.26	0.22	-0.21	0.70	0.41	0.22	0.41	0.57	0.49	1.00												
11. Die in WWI	0.04	0.21	-0.02	-0.09	0.17	0.17	0.08	0.16	0.18	0.14	0.16	1.00											
12.No. of Media	1.60	0.65	-0.15	0.06	-0.21	-0.20	0.07	-0.21	-0.19	-0.09	-0.19	-0.12	1.00										
13. No. of Countries.	1.64	0.59	-0.02	-0.13	-0.01	0.11	0.20	0.14	-0.06	0.09	-0.02	-0.05	0.01	1.00									
14. No. of Movements	1.42	1.03	-0.01	0.02	-0.05	0.11	0.22	0.11	0.00	0.13	0.00	0.07	0.22	0.16	1.00								
15. Primary Media	1.78	1.86	0.00	0.02	-0.03	0.03	0.04	0.04	0.02	0.03	0.10	-0.12	0.18	-0.03	-0.31	1.00							
15. Primary Movement	0.17	0.37	-0.05	-0.01	0.10	0.22	0.16	0.22	0.13	0.27	0.15	0.05	0.14	0.07	0.17	0.04	1.00						
16. French	0.10	0.30	0.04	-0.03	0.22	0.27	0.13	0.26	0.23	0.31	0.29	0.11	-0.14	0.01	0.08	0.02	0.35	1.00					
17. American	0.13	0.34	0.05	-0.07	0.04	0.16	-0.06	0.17	0.08	-0.10	-0.12	-0.08	-0.16	-0.04	-0.07	-0.11	-0.09	-0.13	1.00				
18. Degree Centrality	13.21	7.05	0.08	-0.06	0.08	0.16	0.23	0.14	0.02	0.30	0.21	0.02	0.20	0.15	0.55	-0.23	0.24	0.21	-0.20	1.00			
19. Brokerage	0.79	0.10	-0.06	-0.14	0.04	0.21	0.31	0.19	-0.01	0.35	0.22	0.05	0.18	0.19	0.48	-0.16	0.21	0.17	-0.06	0.82	1.00		
20. Alter National Diversity	0.63	0.26	0.06	-0.06	0.26	0.48	0.41	0.47	0.23	0.48	0.16	0.13	0.06	0.21	0.16	-0.02	0.36	0.16	-0.02	0.30	0.35	1.00	
21. Creativity	-0.02	0.96	0.18	-0.16	0.20	0.28	0.22	0.29	0.20	0.31	0.23	-0.02	0.09	0.15	0.46	-0.19	0.26	0.09	-0.08	0.46	0.42	0.24	1.00

Table 2
Regression Models of Artist Fame in 1926 Using Expert Measure of Creativity

	Fame in 1926				
	(1)	(2)	(3)	(4)	(5)
Age1926	0.412*	0.399*	0.489**	0.457**	0.430**
	(0.210)	(0.212)	(0.216)	(0.204)	(0.206)
Female	-0.672	-0.482	1.098	0.082	0.541
	(4.937)	(4.959)	(4.998)	(4.708)	(4.736)
USFrFame1910	0.413***	0.407***	0.407***	0.337***	0.322***
	(0.098)	(0.098)	(0.097)	(0.094)	(0.095)
Died in WWI	8.951	9.331	8.562	5.854	6.707
	(8.377)	(8.420)	(8.341)	(7.882)	(7.940)
No. of Media	-3.387	-3.677	-3.668	-4.044	-4.035
	(2.896)	(2.934)	(2.902)	(2.730)	(2.732)
No. of Countries	3.398	3.245	2.856	1.123	1.027
	(2.914)	(2.932)	(2.909)	(2.784)	(2.788)
Primary Media	1.400	1.507	1.333	1.258	1.327
	(0.986)	(1.000)	(0.995)	(0.935)	(0.939)
Primary Movement	7.245	6.884	6.928	2.405	1.590
	(4.881)	(4.923)	(4.869)	(4.775)	(4.856)
No. of Movements	2.920	2.262	2.018	2.249	1.703
	(1.842)	(2.066)	(2.049)	(1.927)	(2.013)
American	9.975*	10.641**	8.951*	8.405*	8.767*
	(5.050)	(5.152)	(5.198)	(4.888)	(4.907)
French	6.764	6.132	6.004	6.548	7.031
	(6.158)	(6.241)	(6.173)	(5.805)	(5.832)
Degree Centrality		0.216	-0.374	-0.360	-0.376
		(0.303)	(0.467)	(0.439)	(0.440)
Brokerage			48.334	31.195	28.124
			(29.351)	(28.067)	(28.275)
Alter National Diversity				23.785***	23.670***
				(7.164)	(7.170)
Creativity					1.916
					(2.029)
Constant	-42.234***	-43.346***	-76.209***	-75.317***	-71.382***
	(13.538)	(13.670)	(24.105)	(22.659)	(23.055)
Observations	90	90	90	90	90
R^2	0.437	0.441	0.460	0.529	0.535
Adjusted R^2	0.358	0.354	0.368	0.441	0.440
Residual Std. Error	15.651 (df = 78)	15.700 (df = 77)	15.529 (df = 76)	14.596 (df = 75)	14.606 (df = 74)
F Statistic	5.504*** (df = 11; 78)	5.056*** (df = 12; 77)	4.980*** (df = 13; 76)	6.021*** (df = 14; 75)	5.671*** (df = 15; 74)
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 3
Regression Models of 74 Visual Artists' Fame in 1926 with Computational Measure of Creativity and Exhibition Opportunities

	Fame in 1926				
	(6)	(7)	(8)	(9)	(10)
Age1926	0.401	0.367	0.276	0.335	0.256
	(0.267)	(0.233)	(0.255)	(0.235)	(0.253)
Female	-9.268	-9.501*	-9.179	-9.306*	-9.039
	(5.192)	(5.493)	(5.644)	(5.519)	(5.648)
Fame1910	0.337***	0.290***	0.233**	0.290***	0.235 **
	(0.095)	(0.091)	(0.102)	(0.090)	(0.102)
Died in WWI	8.322	5.214	3.747	3.485	2.440
	(5.984)	(6.318)	(6.044)	(6.868)	(6.528)
No. of Media	-1.300	-1.676	-1.578	-1.219	-1.217
	(2.801)	(2.723)	(2.722)	(2.843)	(2.856)
No. of Movements	1.156	1.805	1.622	1.492	1.381
	(1.773)	(1.660)	(1.690)	(1.761)	(1.787)
No. of Countries	-0.722	-1.673	-0.649	-1.779	-0.788
	(3.129)	(2.920)	(2.939)	(2.928)	(2.942)
Primary Media	0.241	0.635	1.105	0.623	1.071
	(1.176)	(0.881)	(1.011)	(0.887)	(1.020)
Primary Movement	9.405**	4.770	5.659	4.703	5.559
	(3.956)	(4.338)	(4.553)	(4.504)	(4.678)
Productivity	0.082**	0.074**	0.055	0.071**	0.054
	(0.032)	(0.034)	(0.035)	0.034	0.034
American	5.606*	5.739	6.334	6.091	6.585
	(5.929)	(5.955)	(5.853)	(6.112)	(6.020)
French	6.242	6.889	6.708	7.005	6.811
	(5.223)	(5.345)	(5.700)	(5.566)	(5.878)
Degree Centrality	-0.974*	-0.924	-0.944	-1.0154	-1.0158
	(0.570)	(0.556)	(0.581)	(0.592)	(0.611)
Brokerage	101.086**	83.602**	83.608*	84.346*	84.203*
	(43.221)	(43.902)	(45.222)	(43.643)	(45.068)
Alter National Diversity		19.506***	17.831**	19.130**	17.618 **
		(7.238)	(7.385)	(7.413)	(7.543)
Computational Measure of Creativity			0.615		0.597
			(0.632)		(0.583)
Exhibition Opportunities				0.1431	0.114
				(0.218)	(0.219)
Constant	-108.085***	-105.977***	-105.317 ***	-104.681 ***	-104.314***
	(34.067)	(31.928)	(32.3618)	(31.556)	(32.171)
Observations	74	74	74	74	74
Movement Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.521	0.5642	0.5726	0.567	0.574
Adjusted R^2	0.373	0.425	0.382	0.373	0.420
Residual Std. Error	15.264 (df = 60)	14.691 (df = 59)	14.676 (df = 59)	14.775 (df = 59)	14.777 (df = 57)
F Statistic	9.60*** (df = 14;73)	11.53*** (df = 15 59)	10.72*** (df = 16; 73)	12.53*** (df = 16; 73)	11.37*** (df = 17; 73)
Note:					*p<0.1; **p<0.05; ***p<0.01

Table 4: Diff-in-diff results showing negative treatment effect of decreased brokerage for 74 artists whose peers died in World War I (Arellano Bond Panel Estimation)

	Combined Fame
	(11)
Age	0.261**
	(0.104)
Lagged Fame	0.666***
	(0.098)
Productivity	-0.075
	(0.073)
Treatment Dummy (Peer Died)	-10.384***
	(3.462)
Post Treatment Period (post 1913) Dummy	4.067
	(2.505)
Computational Measure of Creativity	0.089
	0.558
Treatment Effect (Effect of Decreased Brokerage Due to Death of Peer in WWI	-3.452*
	(1.876)
Observations	1065
Number of Groups	71
Wald Chi^2(7)	1575.77***
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 5: Structural Equation Model Results Social Structure Shapes Artists' Fame Independent of Creativity

	(12)	(13)
Effects on Brokerage		
Fame in 1909	-0.000	-0.000
	(0.000)	(0.000)
No. of Countries	0.019	0.019
	(0.011)	(0.011)
No. of Movements	0.003	0.003
	(0.007)	(0.007)
Degree Centrality	0.012***	0.012***
	(0.001)	(0.001)
Computational Measure of Creativity	-0.010	-0.010
	(0.018)	(0.018)
Alter National Diversity	0.027	0.027
	(0.032)	(0.032)
Effects on Alter National Diversity		
Fame in 1909	0.002	0.002
	(0.001)	(0.001)
No. of Countries	0.039	0.039
	(0.045)	(0.045)
Primary Movement	0.224***	0.224***
	(0.068)	(0.068)
American	-0.005	-0.005
	(0.068)	(0.068)
French	-0.052	-0.052
	(0.097)	(0.097)
Computational Measure of Creativity in 1909	0.178**	0.178**
	(0.070)	(0.070)
Brokerage	0.398	0.398
	(0.354)	(0.354)
Effects on Computational Measure of Creativity in 1925		
Brokerage	0.018	0.018
	(0.217)	(0.217)
Alter National Diversity	0.162**	0.162**
	(0.079)	(0.079)
Effect of Exhibition Opportunities		
No. of Movements	2.351	2.351
	(1.080)	(1.080)
American	-3.503	-3.503
	(2.570)	(2.570)
French	0.937	0.937
	(3.288)	(3.288)
Computational Measure of Creativity in 1909	10.362***	10.362***
	(2.699)	(2.699)
Brokerage	23.918**	23.918**
	(12.119)	(12.119)
Alter National Diversity	-0.027	-0.027
	(4.126)	(4.126)
Effects on Fame in 1926		
Age	0.147	0.365*
	(0.229)	(0.211)
Female	-8.799	-7.522
	(5.880)	(5.401)
Fame in 1910	0.351	0.315
	(0.107)	(0.100)
No. of Media	-2.449	-1.568
	(2.957)	(2.716)
No. of Movements	1.642	2.177
	(2.248)	(2.063)
No. of Countries	0.239	-1.989
	(3.272)	(3.072)

Table 5 continued

	(11)	(12)
Primary Media	1.291	1.096
	(1.168)	(1.071)
Primary Movement	8.715*	3.850
	(5.051)	(4.898)
American	11.859*	9.844
	(4.952)	(4.545)
French	5.538	7.670
	(7.271)	(6.675)
Degree Centrality	0.098	-1.089
	(0.397)	(0.528)
Computational Measure of Creativity in 1925	16.120 (10.502)	10.655 (9.861)
Exhibition Opportunities	0.310	0.229
	(0.202)	(0.188)
Brokerage		75.222**
		(31.731)
Alter National Diversity		19.513**
		(7.672)
Observations	74	74
Comparative Fit Index (cut-off for good fit ≥0.90)	0.933	0.993
Tucker-Lewis Index (cut-off for good fit ≥0.90)	0.877	0.987
Root Mean Square Error of Approximation (cut-off for good fit <0.08)	0.063	0.020
Standardized Root Mean Square Residual (cut-off for good fit <0.08)	0.042	0.038
AIC	867.429	858.850
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 6
Panel Regression Model Showing that Low Brokerage (High Constraint) in Exhibition Network in Association with Greater Fame (Arellano Bond Panel Estimation)

	(14)	(15)
Career Age	0.746*	0.735*
	(0.424)	(0.429)
Lagged Fame	0.513***	0.508 ***
	(0.154)	(0.147)
Productivity	-0.172**	-0.196**
	(0.086)	.0846285
Degree Centrality in Exhibition Network	0.025	-.003973
	(0.028)	(.0191447)
Computational Measure of Creativity	0.962	.8258474
	(0.929)	(.9626724)
Brokerage in Exhibition Network		-2.977146*
		(1.633065)
Constant	-23.174	-20.65125
	(7.935)	(7.085894)
Observations	216	216
Number of Groups	24	24
Wald Chi^2	58.92***	60.93***
Artist Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes

Figure 1: Our model tests whether social structure shapes fame directly (1a) or through the mechanism of enhanced creativity (1b).

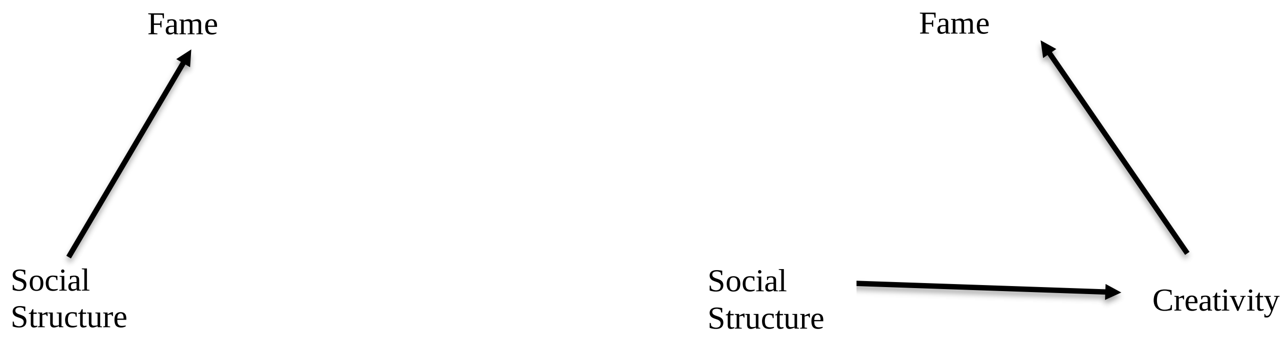
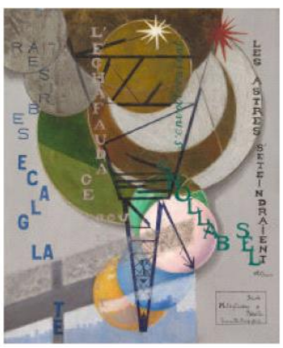


Figure 1(a): Social structure shapes fame directly.

Figure 1(a): Social structure shapes fame through enhanced creativity

Figure 2: Two Early 20th-Century Abstract Artists Suzanne Duchamp and Vanessa Bell, their art work and biographical details



Broken and Restored Multiplication (1919)

Marcel Duchamp's Unhappy Readymade (1920)

Abstract Painting (1914)

Still Life on Corner of a Mantelpiece (1914)

	Suzanne Duchamp	**Vanessa Bell**
Born	1889	1879
Nationality	French	British
Primary Media	Painting	Painting
Formal Training	École des Beaux-Arts	Royal Academy of Art

Figure 3: Fame of two artists Suzanne Duchamp and Vanessa Bell as measured in the Google N-Gram U.S. English corpus

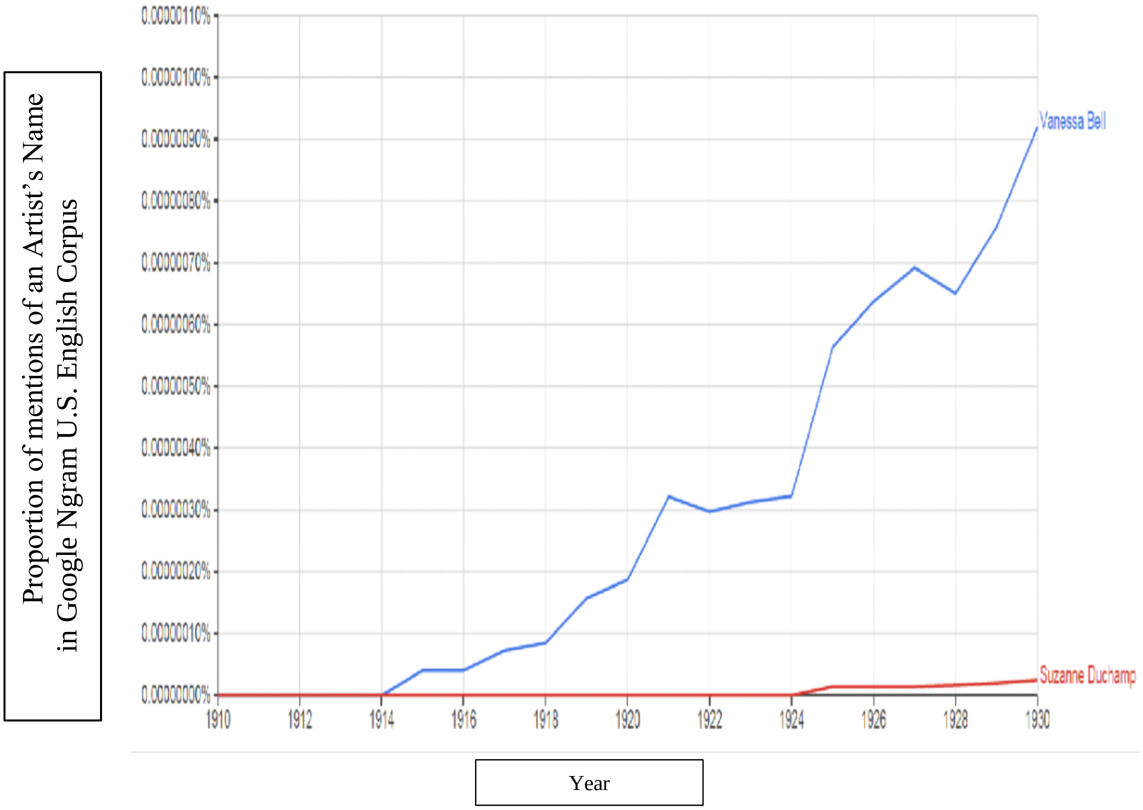


Figure 4: Peer Network of 90 Early 20th Century Abstract Artists

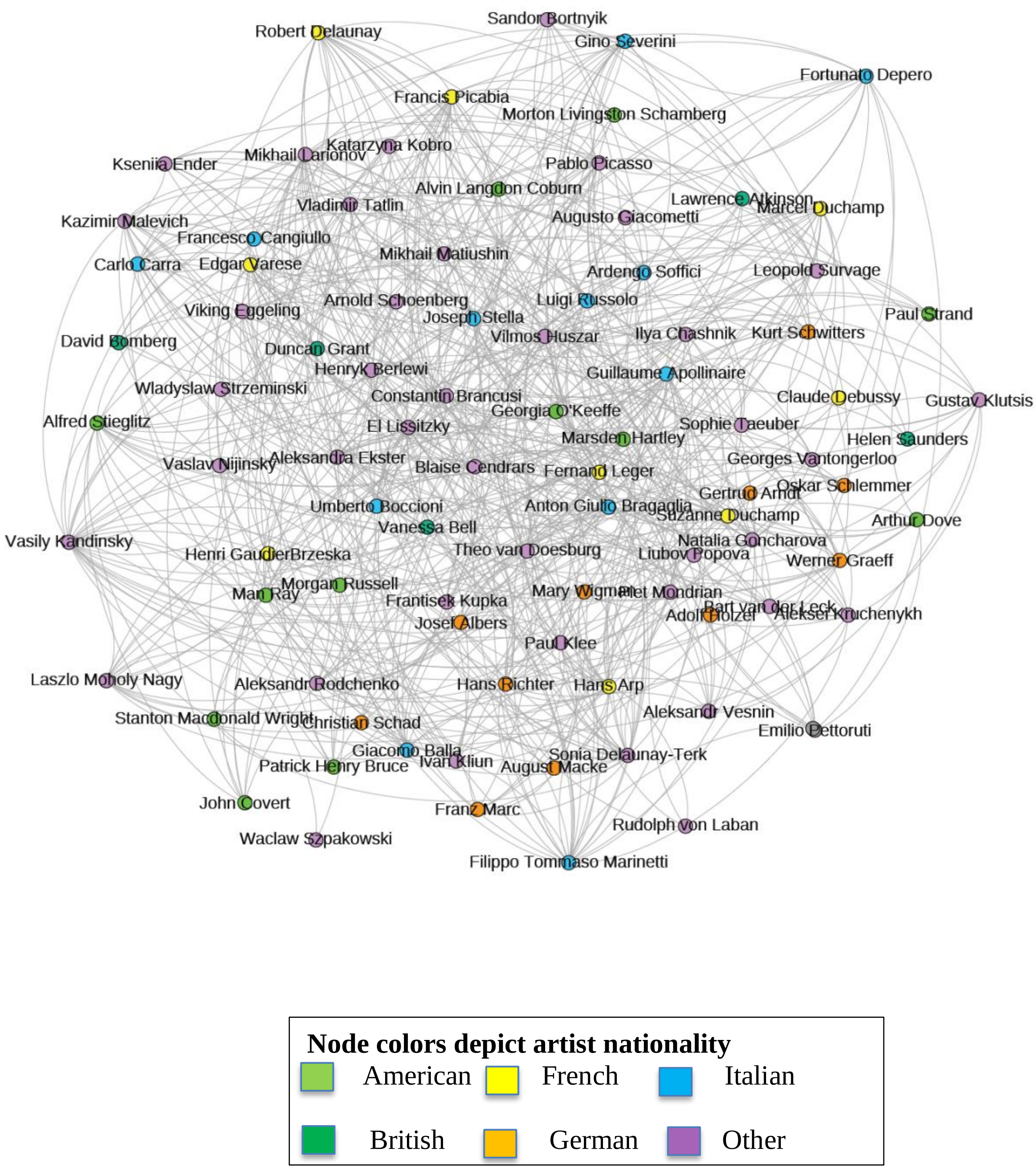


Figure 5: Creativity scores (measured by cosine distance) of two paintings using an image recognition algorithm to represent the paintings.

Figure 5 (a) :The Birds from Xylographies (1909) by Vasily Kandinsky Cosine distance from 19th Century Art = 0.801

Figure 5 (b): Several Circles (1926) by Vasily Kandinsky cosine distance from 19th century art works = 0.869

Figure 6: Artist Frantisek Kupka's Amorpha (figure 6a) is regarded as among first works of pure abstraction. Our computational measure of creativity ranks him as more creative than more famous artists such as Pablo Picasso whose work (e.g. 6 b) had more figurative elements.

Figure 6 (a): Amorpha Fugue in Two Colors (1912) by Frantisek Kupka

Figure 6 (b): Girl with a Mandolin (1910) by Pablo Picasso

Figure 7: Artists' Fame in 1926 Plotted Against (a) the Expert Measure of Creativity and (b) Computational Measure of Creativity

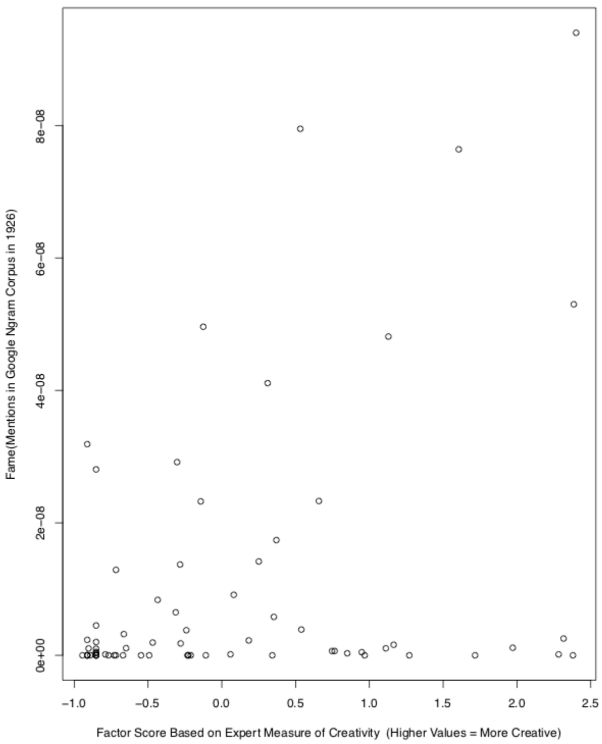


Figure 7(a)

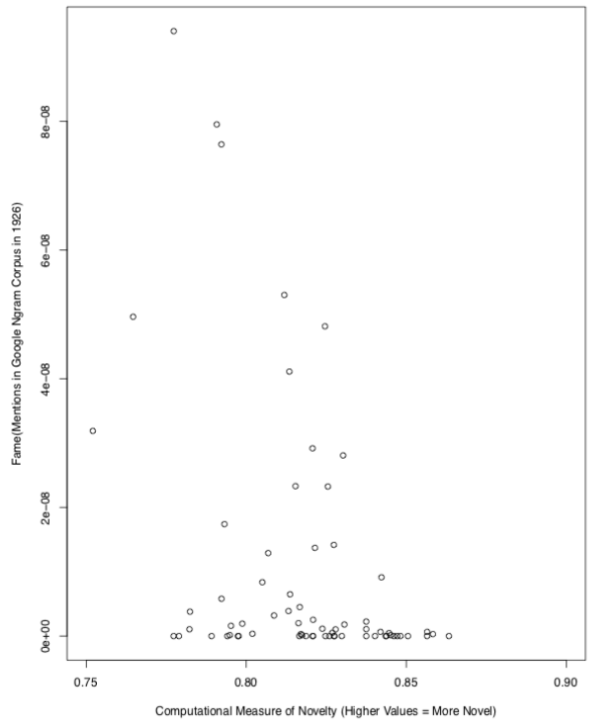


Figure 7(b)

Figure 8: Distribution of artists' fame in 1926 showing that most artists were not famous

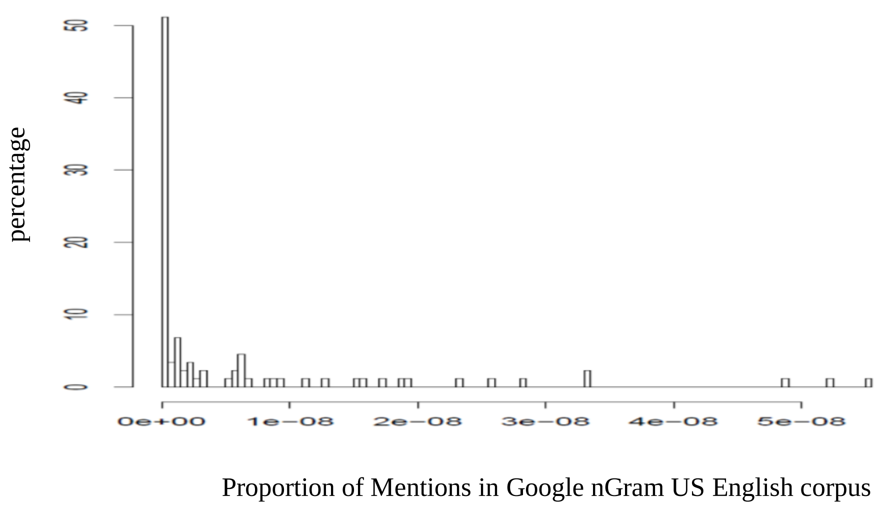
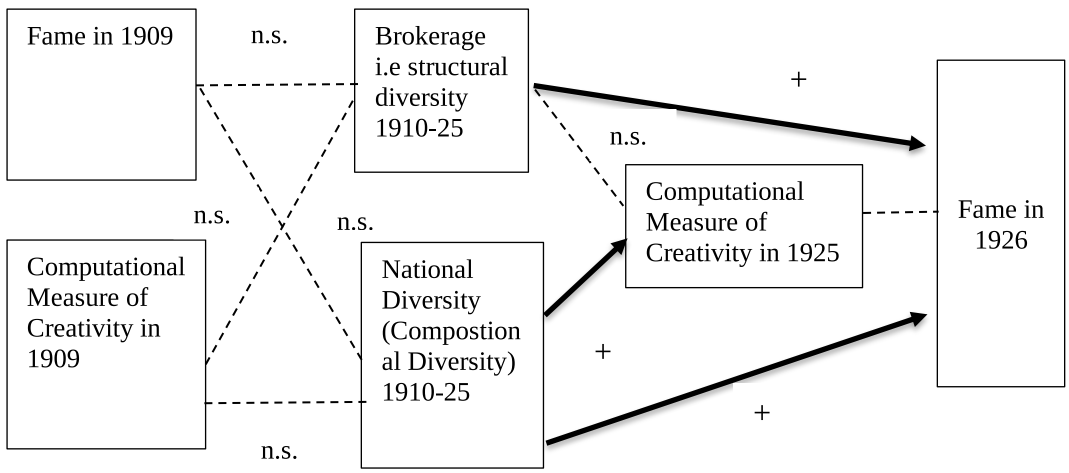


Figure 9: Graphical Summary of Structural Equation Model from Table 5



Broken line (---) indicates no statistically significant relationship between variables in structural equation model
Solid black arrow (→) indicates a positive and statistically significant relationship in structural equation model
n.s = no stastistically significant relationship

Prior fame in 1909 or prior creativity in 1909 does not affect structural diversity or national diversity. Similar to our other models, structural diversity and national diversity have a direct effect on fame in 1926 and not through the mechanism of creativity in 1925. National diversity has a positive relationship with creativity but brokerage does not.

Appendix

Table 1a: The Difference Between Fame and Related Symbolic Capital Constructs

	Fame	**Celebrity**	**Reputation**	**Status**	**Recognition**
Conceptual Basis	Extent of attention in public discourse (Braudy 1997, van Rijt et al. 2013, Shor et al. 2015)	Extent to which an individual elicits positive emotional responses from a broad public audience. Lovelace et al. 2018, Rindova Pollock and Hayward 2006	Evaluation of quality by industry insiders such as peers, subordinates, market intermediaries etc. (Becker 1982; Lang & Lang 1988; Fromburn and Shanley 1990, Sorenson 2014)	Position in a social hierarchy that results from acts of deference (Sauder, Lynn and Podolny 2012)	Extent to which one is well-regarded by industry insiders such as peers, critics, etc. Similar to reputation though can be bestowed posthumously (Lang & Lang 1988 ; Jones 2010,Williamson 1991
Domain	Across Domains- Culture wide	Across domains - Culture Wide	Domain specific- derives from assesement of quality of producer's output.	Domain specific	Domain specific
Valence	Positive, Negative or Neutral	Positive	Positive or negative	Follows an ordering from high to low.	Positive
Operationalization	Mentions in newspapers (van Rijt et al. 2013, Shor et al. 2015)and books (Michel et al. 2011);	Media awards (e.g.Financial World's CEO of the Year Wade et al. 2006)	Performance records, Quality evaluations (e.g Fortune Magazine's Firm reputation score) Fromburn and Shanley 1990; Rindova et al. 2005;Phillipe & Durand 2011;	Affiliation to entities (e.g. strategic alliances to firm(Stuart); position in published tombstone adversities of financial security offering (Podolny & Phillips 2006)	Awards (Cattani, Ferriani and Allison 2014; , Scientific Publication Citation Count*, Mentions in industry specific publications (Giuffre 1999(Jones 2010;

*Scholars have used citation counts of academic journals as a measure of *field specific* visibility (Leahey 2007 p.) which differs from fame. Fame arises from broad culture wide visibility

Table 2a: Selected Prior Studies on the Relationship between Social Structure and Symbolic or Economic Success in Creative Industries

Type of Success	Social Structural Features	Type of Social Structure	Level of Analysis	Selected Examples
Posthumous Industry recognition (Eminence)	Association with peers and mentors	Direct and indirect ties to peers and mentors	Individual	Lang and Lang (1988) find that association with elite peers increases the likelihood of posthumous recognition for painter-etchers Collins (2000) argues intellectuals (e.g. poets, philosophers, writers) who were connected to peers through schools/movements and to prominent mentors were more likely to be receive mentions in professional publications after their death and thus survive in collective memory. Also see Jones (2010) below.
	Presence or absence of ties	Ties to surviving relatives.		Lang and Lang (1988) find painter-etchers survived by family members were more likely to receive mentions industry publications after their death.
Industry Recognition (Mentions in Industry Publications)	Membership in dense vs. sparse peer groups within an industry	Indirect ties to peers through membership in third party institution.	Individual	Giuffre (1999) finds that relative to photographers' embedded in dense networks, those embedded sparse networks (low constraint) were likely to have greater number of reviews in two industry journals, *ArtNews* and *Art in America.* Each photographer was assigned to a block of structurally equivalent photographers who shared the same level of density. Two photographers have a tie in the network if they are represented by the same gallery.
	Degree centrality in social and symbolic networks	Direct ties to peers, and mentors through collaboration on projects. *Symbolic Network*: Co-mentions with other producers in critical texts.	Individual	Jones (2010) finds that architects with higher degree centrality in symbolic networks of peers and mentors were likely to receive more mentions in industry publications later in their career and after their death. In contrast, she finds that architects' degree centrality social networks had little influence on recognition.
	Association with mentors.	Direct ties to prominent mentors	Individual	Williamson (1991) finds that architects who apprenticed with famous architects were more likely receive mentions in a sample of sixty industry publication
Industry Reputation (Critics Evaluation/Ratings)	Social and cognitive overlap within teams	Indirect ties between producers based on collaborating on projects	Team	De Vaan, Stark and Vedres (2014) find that video games produced by developer teams comprised of groups with greater social overlap (higher number of past collaborations) and greater cognitive diversity (exposure to more diverse stylistic elements) are likely to greater critical acclaim
Industry Recognition (Industry Award or Nomination)	Core vs. periphery position within global network of	Indirect ties between producers based	Individual and project based	Cattani, Ferriani & Allison (2014) find that that film professionals situated at the periphery of Hollywood are less likely to be nominated by their peers for industry award (e.g. Oscars, Screen

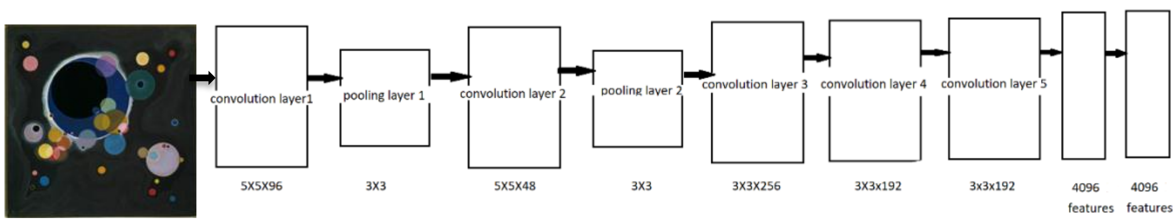
	peers within an industry	on collaborating on projects		Writers Guild Award) and more likely to be nominated by critics for industry awards.
Financial Success	Clustering coefficient of *global* network of peers an industry	Ties between innovators based on direct and indirect collaboration on projects	Mutilevel- project and industry	Uzzi & Spiro (2005) find a curvilinear relationship the box-office success of Broadway musicals and small world nature (measured by the industry's global clustering coefficient) of the musical industry collaboration network. They also find the same curvilinear relationship for critics' evaluations.

Table 3a: Further Details Image Recognition Algorithm

We use the Caffenet algorithm based on Jia et al. (2014) and Krizhevsky, Sutskever and Hinton (2012) to represent each image. The algorithm was pre-trained on 1,034,908 million non-art images and 21841 classes or groups. We do not use the image for any prediction.

The input to the algorithm is an 224 X 224 matrix of pixels where the pixels are RGB (Red Green Blue) values. The output is a 4096 dimensional vector representation of the image (for further details please see Appendix 3a) .

As shown in the figure 1a below, the input image is passed through a six convolution and pooling layers. A convolution layer breaks an image into small parts to get an array representation. A pooling layer reduces the dimension of an array representation. The final output is a 4096 vector representation.



Input image 224X224 pixel   neural net withconvolutional and pooling layers   output of 4096 dimensional vector representation of image

The first convolutional layer filters the 224×224×3 input image with 96 kernels(filters) of size 11×11×3. The second convolutional layer takes as input the (response-normalized and pooled) output of the first convolutional layer and filters it with 256 kernels of size 5 × 5 × 48. The third, fourth, and fifth convolutional layers are connected to one another without any intervening pooling or normalization layers. The third convolutional layer has 384 kernels of size 3 × 3 × 256 connected to the (normalized, pooled) outputs of the second convolutional layer. The fourth convolutional layer has 384 kernels of size 3 × 3 × 192 , and the fifth convolutional layer has 256 kernels of size 3 × 3 × 192. The fully-connected layers have 4096 neurons each.

Parameters:
Batch size: 128
Momentum v: 0.9
Weight Decay: 0.0005
Learning rate ϵ: 0.01, reduced by 10 manually when validation error rate stopped improving, and reduced by 3 times.
Pooling filters —

1. Conv layer 1 = 96
2. Conv layer 2= 256
3. Conv layer 5= 256

Table 4a: Separate Regression Analyses of U.S. and French Fame in 1926

	French Fame 1926				US Fame 1926			
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)	(7a)	(8a)
Age1926	0.500**	0.417*	0.465*	0.389*	0.566**	0.528**	0.534**	0.498**
	(0.231)	(0.218)	(0.234)	(0.221)	(0.215)	(0.203)	(0.217)	(0.205)
Female	-0.709	-1.511	-0.247	-1.116	1.662	0.742	2.217	1.273
	(5.521)	(5.183)	(5.550)	(5.216)	(4.975)	(4.701)	(4.996)	(4.721)
FrenchFame1910	0.388***	0.375***	0.367***	0.358***				
	(0.130)	(0.121)	(0.132)	(0.124)				
US Fame1910					0.378***	0.316***	0.358***	0.298***
					(0.100)	(0.096)	(0.101)	(0.097)
Died in WWI	6.460	2.748	7.296	3.490	9.335	6.693	10.432	7.747
	(9.068)	(8.573)	(9.123)	(8.639)	(8.319)	(7.889)	(8.372)	(7.940)
No. of Media	-1.530	-1.662	-1.580	-1.702	-4.767*	-5.141*	-4.824*	-5.192*
	(3.206)	(3.007)	(3.210)	(3.014)	(2.820)	(2.662)	(2.817)	(2.660)
No. of Countries	1.640	-0.216	1.484	-0.326	4.164	2.396	4.001	2.254
	(3.203)	(3.053)	(3.211)	(3.062)	(2.902)	(2.791)	(2.903)	(2.791)
Primary Media	0.498	0.456	0.598	0.539	1.334	1.311	1.439	1.411
	(1.102)	(1.033)	(1.108)	(1.041)	(0.991)	(0.935)	(0.995)	(0.938)
Primary Movement	8.195	2.960	7.236	2.218	8.238*	4.027	7.415	3.275
	(5.348)	(5.246)	(5.454)	(5.335)	(4.624)	(4.550)	(4.681)	(4.598)
French	7.103	7.252	7.650	7.709				
	(6.798)	(6.375)	(6.831)	(6.413)				
American					8.707*	8.245*	9.137*	8.654*
					(5.162)	(4.871)	(5.171)	(4.880)
No. of Movements	0.350	0.704	-0.259	0.191	1.366	1.749	0.752	1.167
	(2.250)	(2.113)	(2.348)	(2.209)	(2.036)	(1.924)	(2.111)	(1.995)
Degree Centrality	-0.331	-0.311	-0.356	-0.331	-0.265	-0.263	-0.285	-0.281
	(0.496)	(0.466)	(0.498)	(0.467)	(0.463)	(0.437)	(0.463)	(0.436)
Brokerage	64.825**	45.411	62.188*	43.428	47.667	30.533	43.727	26.918
	(31.841)	(30.398)	(32.002)	(30.561)	(29.247)	(28.087)	(29.441)	(28.252)
Alter National Diversity		26.054***		25.755***		23.136***		22.987***
		(7.660)		(7.685)		(7.124)		(7.118)
Creativity			2.174	1.819			2.321	2.194
			(2.368)	(2.226)			(2.146)	(2.024)
Constant	-93.333***	-87.882***	-89.465***	-84.709***	-81.155***	-79.526***	-76.320***	-74.965***
	(27.467)	(25.806)	(27.816)	(26.153)	(23.895)	(22.544)	(24.283)	(22.908)
Observations	90	90	90	90	90	90	90	90
R^2	0.387	0.468	0.394	0.473	0.445	0.513	0.453	0.520
Adjusted R^2	0.291	0.377	0.290	0.374	0.358	0.429	0.360	0.430
Residual Std. Error	17.081 (df = 77)	16.017 (df = 76)	17.099 (df = 76)	16.052 (df = 75)	15.471 (df = 77)	14.593 (df = 76)	15.454 (df = 76)	14.577 (df = 75)
F Statistic	4.048*** (df = 12; 77)	5.139*** (df = 13; 76)	3.794*** (df = 13; 76)	4.799*** (df = 14; 75)	5.143*** (df = 12; 77)	6.147*** (df = 13; 76)	4.848*** (df = 13; 76)	5.805*** (df = 14; 75)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 5a: Models showing our social structural variable of brokerage and compositional diversity continue to be positively associated with fame in the year 2000

	Fame in 2000			
	(9a)	(10a)	(11a)	(12a)
Age1926	0.324***	0.309***	0.335***	0.321***
	(0.120)	(0.116)	(0.122)	(0.118)
Female	-5.512*	-5.956**	-5.701**	-6.158**
	(2.779)	(2.690)	(2.803)	(2.713)
Fame1910	0.084	0.054	0.091	0.061
	(0.054)	(0.054)	(0.055)	(0.054)
Died in WWI	1.406	0.225	1.058	-0.151
	(4.637)	(4.504)	(4.684)	(4.548)
No. of Media	1.232	1.068	1.229	1.064
	(1.613)	(1.560)	(1.619)	(1.565)
No. of Countries	1.967	1.211	2.010	1.253
	(1.617)	(1.591)	(1.625)	(1.597)
Primary Media	0.433	0.401	0.405	0.371
	(0.553)	(0.535)	(0.557)	(0.538)
Primary Movement	2.055	0.082	2.402	0.441
	(2.707)	(2.728)	(2.767)	(2.781)
No. of Movements	1.584	1.685	1.810	1.926*
	(1.139)	(1.101)	(1.193)	(1.153)
American	-2.009	-2.247	-2.158	-2.407
	(2.889)	(2.793)	(2.909)	(2.811)
French	0.666	0.904	0.465	0.691
	(3.432)	(3.317)	(3.458)	(3.340)
Degree Centrality	-0.378	-0.372	-0.371	-0.365
	(0.260)	(0.251)	(0.261)	(0.252)
Brokerage	36.330**	28.854*	37.638**	30.208*
	(16.317)	(16.038)	(16.498)	(16.196)
Alter National Diversity		10.375**		10.425**
		(4.093)		(4.107)
Creativity			-0.794	-0.844
			(1.204)	(1.162)
Constant	-61.366***	-60.977***	-62.999***	-62.711***
	(13.401)	(12.948)	(13.677)	(13.206)
Observations	90	90	90	90
R^2	0.347	0.399	0.351	0.403
Adjusted R^2	0.235	0.286	0.230	0.282
Residual Std. Error	8.633 (df = 76)	8.340 (df = 75)	8.665 (df = 75)	8.367 (df = 74)
F Statistic	3.108*** (df = 13; 76)	3.550*** (df = 14; 75)	2.895*** (df = 14; 75)	3.328*** (df = 15; 74)

Note:
*p<0.1; **p<0.05; ***p<0.01

Table 6a: Formulas

Compositional Diversity of Artist i = $\frac{\left(1-\sum_{j=1}^{K}(Pj/Ni)^2\right)K}{K-1}$, where

P_j = Number of of artist i's alters that have nationality j
N_i = Total number of alters of artist i (i.e. degree centrality of artist i)
K = Total number of nationality categories in our sample
P_j/N_i = Proportion of arists's i's alters with nationality j