

## **John Padgett application for SFI Research Professor**

September 10, 1999

I will describe my research interests in the following sequence:

- (a) the substantive phenomenon I wish to explain is the emergence of banking in Renaissance Florence;
- (b) the evolutionary process exemplified in this case is speciation—in particular, speciation viewed “metabolically” as the altered concatenation of multiple production networks;
- (c) modeling the dynamics of multiple networks, to predict alternate trajectories of “structural attainability” in both social and chemical systems, is a next research step;
- (d) I propose concrete activities, in pursuit of this agenda, at the end of this application.

### The Emergence of Banking in Renaissance Florence

I have presented my research on both the politics and the economics of Renaissance Florence on numerous occasions at SFI, so only a brief sketch will be provided here. The first and foremost purpose of my application is to write up this research into a book.

Northern Italy in general, and Florence in particular, are well known for being the locus of an extraordinary array of organizational and technical inventions that changed the direction of Western history. These inventions were produced more-or-less simultaneously not only in the “high culture” fields of art (Masaccio, Alberti, Michelangelo, etc.), of architecture and engineering (Brunelleschi, Leonardo, etc.), and of political theory (Machiavelli, Guicciardini, Bruni, etc.), but also in the practical organizational domains of politics (electoral republicanism), of kinship (dowries), and of economics (bills of exchange, money markets, insurance, double-entry booking, limited-liability partnerships). Modern specialist, and revisionist, scholarship has led the current generation of researchers away from the most interesting, and classical, questions: namely, what are the connections among these various domains of invention? Not just how is “an” invention produced, but how are new self-sustaining chains or ecologies of inventions generated? What makes some times and places, both in species evolution and in human history, simply more fertile for the creation of explosively new chains of inventions than others?

My own primary research focuses not on the domains of high culture (although I have taught these subjects). It focuses rather on the description and explanation of changing interconnections among politics, kinship, and economics within Florence across the two centuries of 1300 to 1500. Because of this empirical focus on social underpinnings, “invention” in my research means invention of new organizational forms, more than it does invention of new techniques. These two levels of analysis are connected causally, however, since change in organizational form usually temporally preceded change of production technique: managing new forms of human interaction was

the drive behind the search for new forms of economic, political, artistic, and even psychological technique. Technical solutions usually followed new problems, which however were in turn generated by new solutions in the cascading way alluded to above. Narratively, the two levels of analysis are connected since I can rely on an extremely rich secondary literature on changing technique to supplement my own primary research on changing organization form.

My methodological approach is social networks. In the archives I have collected exhaustive information on economic, political, and kinship networks over two centuries. Just to give a concrete idea of the empirical foundation of my research, I have personally coded from the Florentine archives and have in my computer:

- 1) 10,000+ dated marriages among Florentine families, based on registries of dowry contracts, most of the originals of which are now lost;
- 2) an annual census by the banking guild of all active domestic bank partnerships, from 1340 to 1500; also the annual registration of new matriculants to the guild, from 1299;
- 3) occasional censuses of all wool and silk production firms;
- 4) tax censuses of the entire Florentine population in 1351, 1378, 1403, 1427, 1458, and 1480, roughly 8000 households each year; [1427 and 1480 were coded by other researchers; 1403 was coded by my Italian RA, using SFI research support]; these tax censuses include residence as well as financial information;
- 5) 14,000+ transactions (actually debts/credits) among Florentine companies in 1427, coded by a previous student of mine, Paul McLean, under my direction;
- 6) transactions from the account books of three international banks (Strozzi, dellaCasa/Guadagni, and Alberti);
- 7) two centuries of political participation in city council (2-month terms) and other special reform boards;
- 8) political faction memberships for six “realignment” periods, coded from secondary sources;
- 9) 300+ political patronage letters, asking for favors of various kinds, collected by Paul McLean for his dissertation.
- 10) About half of the above is now integrated into a unified relational data base, no small task in and of itself.

This quantitative-history data set, covering as it does 200 years (150 years very thoroughly), is actually unprecedented not just in the field of Florentine studies, but in the field of economic history more generally. [Only the work of Bob Fogel is in the same league.] Needless to say, this data set is possible only because of the extraordinary richness of the original Florentine records, meticulously preserved—itsself a testament to the bookkeeping and measurement innovations of the time. The data set’s integration of economic networks of partnerships and transactions with temporally parallel political and kinship networks permits a uniquely wide and cross-domain view of the linked transformations in each. Down the road, after donation to the public, this data set may well become the *e coli* of social history.

As I have described in numerous SFI lectures, one of the main discoveries I have made in this data set is the temporal coevolution of political parties and banking markets through four stages. [Kinship and marriage evolved as well, but on a slower time frame]. (1) From pre-1300 to about 1340, businesses and political factions were both based primarily on the social foundation of patrilineal family; (2) from about 1340 to 1380, businesses and political factions were based primarily on the social foundations of neighborhood and guild; (3) from 1380 to 1440, businesses and factions were based primarily on oligarchic social class; and (4) from 1440 through 1500, businesses and factions were based primarily on vertical ties of patronage. These statements are based on statistical analyses, but my ex-student Paul McLean has shown in his dissertation that similar trends held in the domain of language. Within a decade after network behavior changed, people of the time began asking, arguing with, and denouncing each other, both in public speeches and (more heterogeneously) in private letters, in verbal terms parallel to these.

The phenomenon to be explained is not changing social networks per se: family, neighborhood, social class, and patronage all remained salient social realities in Florence throughout the entire Renaissance period. Rather, the phenomenon to be explained is that, for whatever reasons, both politics and economics realigned themselves into these different dimensions of the surrounding social matrix--foregrounding one social network to be "hegemonic" or constitutive of organizational actors in one phase and another network to be constitutive of actors in another phase. [To take a contemporary analogue, the fact that marriage is not relevant to American business today does not mean that marriage is not important to the people involved; nor that it could not become central to the construction of new firms in a future mode of organizing business.] While Florence was in no way unique in this generic process of realignment, what is less common is the speed or frequency of these realignments in Florence during the Renaissance. The pressure such wild social-organizational gyrations placed on the search for technical innovations, to help understand and stabilize them, was considerable.

On the strictly economic plane of banks, transformation in the nature of firms had direct consequences for transformation in the organization of markets and in the means of transacting between firms.

- (1) In the first family phase, firm size distributions were very concentrated, as banks could grow up to the limits of (very large) patrilineal clans. Market competition was extreme, extending well beyond polite price competition to treachery, thuggery and theft, since banks were merely one wing of families at war. Cross-firm mobility was nil, tying the banker's fate to the bank (hence unlimited legal liability). In order to minimize dependence on competitors, banks strove for "full service" vertical integration, integrating loans with exchange with trade with diplomacy. Those few inter-bank transactions still necessary were handled through notarized contracts, which presupposed distrust.
- (2) In the guild phase, firm size distributions were deconcentrated, as banks constantly splintered because apprentices hived off to start their own firms or to recombine. High inter-firm mobility produced an "industrial district" type of market, where

friendly competition was tempered by dense informal and formal regulation. Guildsmen bankers sat around the piazza conducting business, and shooting the fat. [Overseas, Florentines clustered spatially in foreign capitals the same way.] Contracts evolved into account books as bankers learned just to walk across the piazza and scratch off entries in tandem. Such solidaristic trust, rooted in neighborhood and guild, enabled inter-bank transfers and rollovers, and hence the creation of “bankers’ money” through float.

- (3) In the social class phase, guild-based industry solidarities were politically repressed, and cross-industry “conglomerates” formed. Banks, silk firms, wool firms, and trading companies became linked through overlapping ownership/partnership networks, in a manner reminiscent of business groups today. Such partnership networks were the economic foundation for a new city-wide political oligarchy, which celebrated itself through civic humanism and art. Industrial heterogeneity within firms, however, created organizational control problems, which led to a push towards abstraction, to make the disparate comparable. Double-entry bookkeeping, the manifestation of abstraction in business, became transformed from a curiosity into an industrial standard during this *popolani* period.
- (4) In the Medicean patronage phase, the upper tiers of banking were absorbed into the state, both sides increasingly preoccupied with lucrative (but politically risky) state finance. The banking industry as a whole shattered into three segments: quasi-state financiers, overseas merchant-banker exiles, and impoverished local bankers. These three segments were linked not through partnerships but through big loans. [These loans gradually evolved into *accomandite* “silent partners” over time.] “Finance” for the first time became a specialized role, separated from trading and entrepreneurship. Wealth concentration, as opposed to firm-size concentration, in the city was extreme, as political connections both within the Florentine state and to dignitaries abroad mattered much. Eventually these external ties exploded the Florentine state (although not immediately Florentine wealth).

Two broad features in this schematic history stand out. On the one hand, even though I exaggerate somewhat the intra-period homogeneity, each phase was a distinct economic regime, with its own style of making firms, doing business, competing, and reproducing itself through careers. As such, each regime can certainly be analyzed and modeled internally, on the economic plane alone, using standard equilibrium tools without bringing in politics, kinship, social networks and all the rest. We then simply would have four different equilibrium models. On the other hand, the constitutive centrality of politics and social networks becomes especially apparent during the times of regime transition. [This point would be even more obvious in the fuller presentation of transition dynamics I give in my lectures.] The fact that politics and social networks often retreat to the background of self-consciousness during times of regime stasis should not obfuscate another fact that all action and all innovation exist in a context. Such a political and social network “context” constructs, I claim, the core nature of the economic entities being analyzed--routinely in times of regime stasis, more obviously yet unpredictably in times of regime transition. The analytic challenge for the study of regime transition, of course, is that “context” does not remain fixed, but rather is dynamically searched

through, remolded, and propped up by the very processes being shaped by it. Hence, not “the evolution of markets,” but rather “the coevolution of states and markets.”

### Speciation and Heterarchy

Without proclaiming prematurely to know the similarities and differences between human and animal evolution, it is provocatively interesting to consider my problem of regime transition as analogous to the biologists’ problem of speciation. The standard population geneticists’ approach of speciation-as-isolated-gene-pools seems not terribly germane to my case. But the more heterodox functional approach of speciation-as-new-ways-of-making-a-living seems to me promising indeed. It urges a more metabolic or processual understanding of organism, and thereby a different conceptualization of organism sequence—namely, evolution as a phylogeny of (transaction and production) flows, underneath the more observable phylogeny of objects. The history of banking, for example, underneath the sequence of banks. The theoretical appeal of such an approach is that it promises to integrate organism and context more deeply than does population sampling. The drawback is empirical: relations (either transactional or transformational) are harder to count than things. It is not easy for paleontologists to infer chemistry and ecology from fossils. But in a meticulously documented “total community” like Renaissance Florence, the data barriers are somewhat less daunting.

What would such an approach mean for my case? And how can my case contribute to the development of this theoretical perspective on evolution?

First of all, what are “flows”? In banking, flows are people and money. People flow in and among banks through careers. Money flows in and among banks through credit and loans. Conversely, banks are congealed nodes or “knots” linking these two sets of flows to each other. Not only spatial, firms are autocatalytic, in the sense that they have properties-in-context that enable the perpetuation of both career and credit flows to and from them. Speciation, in this functional view, is a self-reproducing change in the rules (or “protocols”) through which people and/or money flow among firms. Changes in observable morphology, such as organizational form, are major clues to (and consequences of) speciation events, but relational changes in production flows need to be confirmed directly, in order empirically to separate appearances from true innovation.

Rule changes per se can vary continuously in magnitude, in both human and animal populations. Hence species are discrete only because of a concatenated meta-population dynamic of convergence on “industry standards” of interaction, which convergence enables the resulting population reliably to reproduce. Even so, the functional view implies a much more nested conception of species’ relatedness than does the discrete population image of isolated gene pools. Behavioral protocols, just like human languages, are identifiably clusterable, in spite of the many dialects and permutations within.

In spite of the ontological appeal of this approach, and of its greater relevance to human history, theoretical developments in this alternative line have not been overwhelming. Spectacular discoveries in molecular biology have transfixed the neighboring field of evolutionary biology into a gene-centered, not a metabolism-centered, worldview. Emboldened by my knowledge of Florentine history, however, and by what I see at the Santa Fe Institute, I am convinced that fundamental work on “structural attainability” is within reach, if multiple-network tools from the social sciences and autocatalysis tools from chemistry can be combined.

From the vantage point of my case, a key missing ingredient in the functional approach in evolutionary biology is an adequate conceptualization of “context”. The otherwise appealing concepts of context-dependence and of path-dependence degenerate into catchwords without a clear understanding of the neighborhood of action. Steven Jay Gould has shown us over and over again examples of biological speciation as the story of the organism taking one capacity and using it for a completely different purpose. Success then refines the gerry-rigged gimmick into something passably useful. Stories of human technological advance often take the same “socially embedded” form. No matter how truthful and compelling, however, one cannot translate these vignettes into science without a better topology of capacities and tasks.

Social science offers one possible methodology, multiple networks. The “context” of one network of interaction is the set of other networks in which those nodes are also engaged. Nodes thereby link or “staple together” networks. Gerry-rigged invention, from the perspective of a node, is transposition of capacity from one network to another, from the perspective of the system. How different nodes develop and innovate is a function of which segments of different networks they connect. Multi-functionality (i.e., single actions that operate in two networks at once) is a nodal feature with particularly strong system control consequences, as I showed in my previous research on the Medici.

Clustering concepts are pervasive in social network analysis. The best candidate in my mind for deriving “modules”, or at least proto-modules, from multiple networks of interaction is structural equivalence: the set of nodes linked similarly to other (sets of) nodes. It is easy to derive “industries” from (firm-level) Leontiev input-output tables using this method; it would be interesting to try to derive “organs” from metabolic chemical networks using the same (or a competing) procedure. The point is that with multiple-network methodology the translation between the relational and the morphological perspectives is smoother than one might think. Modules congealing out of networks of interaction; networks constructed by reproducing modules: these are but flip sides of the same process.

The theoretical task then—both in order to abstract Florence and in order better to understand speciation (which is really the same thing as regime transition)—is to integrate the multiple-network perspective from the social sciences with the functional approach to evolution from the biological sciences. Both from thinking hard about my case and from conversations at SFI, moreover, I have come to the conclusion that the key

to such a theoretical integration, in turn, is the concept of communication protocol. This is what I would work on, were I to come to SFI.

Protocols are important because they are the “language of flow”. All flows—be they people, money, or molecules—have many faces (that is, ways they can act and be used), depending on the setting and on the other flows they are interacting with. Thus for production to occur, and for modules such as banks to reproduce, the “faces” of the elements flowing together must be recognized, “understood”, and aligned with each other. One important aspect of speciation, from the functional point of view, is a shift in these terms through which the organisms “see” their environment. In the Florentine case, regime transition was not primarily a matter of one set of bodies out-competing and pushing another aside. It was more a matter of realignment of more-or-less the same bodies into their social matrix differently, via a change in the collective protocol recognition of their own identities: the “person” behind the banker shifted from father to guild master to patrician to patron. The logic through which people and money combined into banks, and hence the nature of the banks themselves, changed accordingly.

Indeed, assuming flows are there in requisite volume to begin with, raw chaotic flows settle down into stable autocatalytic networks in the first place via their alignment and recognition by communication protocols.

The study of the endogenous emergence and transformation of communication protocols is, therefore, the next major agenda item on my intellectual horizon. Were I to come to SFI, I would hope to interest and recruit others in this topic.

### Modeling

I have been asked innumerable times during my visits to SFI: “when are you going to translate all this into a model?” I have indeed responded to this persistent question with my hypercycle model/paper, which transposes some of Walter Fontana’s lambda-calculus ideas into the domain of economic organization. But the truth of the matter is that this will never happen if I stay at Chicago. It will only happen if I move, at least for a while, to Santa Fe. This is not because of a lack of interest or ability on my side; most of my publications are math models of various sorts, as anyone who is interested can see. It is simply that my commitment to data is all consuming. Without a co-author to apply gentle countervailing pressure, I have decided over and over again, in the privacy of my own office, that getting Florence right is just more important in the long run than any model.

While I still fundamentally believe this, I was and am attracted to SFI in the first place because of the power of the vision lying behind the various autocatalytic models I saw there. Far too abstract to have any relevance for Florence per se, these models nonetheless embody potent self-organizational principles which I see instantiated in much richer form in Florence. [Generative algebras, for example, are common in my own social network field.]

Walter Fontana's lambda-calculus platform is production, not communication oriented, which naturally is a problem for the study of the emergence of communication protocols. Walter has informed me (without really educating me) about Robin Milner's communication-oriented pi-calculus extension, which may or may not prove to be a more suitable platform. How exactly to operationalize formally the study of emergent protocol—and thereby the transformation of flows into regulated networks—is an extended future conversation that can only happen on site (between Walter, myself, and hopefully Jim Crutchfield). Such a study I regard as crucial to the pursuit of any “structural attainability” agenda at SFI.

On a less abstract plane, for the past two summers, during the month of June, I have assembled a working group of empirically-oriented social scientists interested in the emergence of markets, of a variety of sorts. A number of people have cycled through, but the core, besides myself, includes David Stark, who studies both the post-Communist transition in Eastern Europe and the emergence of e-commerce “Silicon Alley” in Manhattan, and Walter Powell, who studies the emergence and transformation of biotech in the U.S. All three of us have very serious network data sets, over time. Our daily collective group meetings essentially were detailed “compare and contrast” sessions, where we searched for common unifying themes. What emerged as crucial to our understanding of the process of new industry formation were (a) heterarchy—the coexistence of multiple frames of accountability, and (b) the duality of organizational foundings and individual careers.

The next step for our group would be to hire a grad student or post-doc to help us set up a simulation platform, within which our three cases could be represented in schematic form. Since heterarchy and duality would be central, such a simulation might well have the visual “feel” of amoebas (or hypercycles?) growing through various multidimensional network spaces, transmuting in the process. Network models of markets already exist in the economics literature, but these refer to transactions, not to firm-founding patterns.

### Proposed Activities

Concretely, what I propose to do were I to become a SFI Research Professor is this:

- (1) First and foremost, I want to finish my book on Florence.
- (2) With Walter Fontana and hopefully Jim Crutchfield, I want to develop the “structural attainability” component of the Keck grant. In addition to internal conversations, this entails a series of visitors and workshops. Without my physical presence at SFI, I fear that this component of the Keck initiative will not succeed.

- (3) I wish to continue my ongoing “coevolution of states and markets” June working group, changing characters as appropriate. This group has the advantage of being deeply grounded in rich actual cases. Conversations have now proceeded to the point where formalization is, for the first time, envisionable.
  
- (4) I would like, at least once, to assemble a workshop or a working group of world-class historians of Florence, to talk not about generalization but about Florence itself. The quantitative/scientific approach is not common in Florentine historiography; hence serious research conversation that spans methodologies over common questions needs to be sustained, to the benefit of both sides.

I hope SFI will find these ideas and activities attractive as one component of its rich cross-disciplinary mix.