Local and Social: Entrepreneurs, Information Network Effects, and Economic Growth

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Abstract

Information is an essential input to the entrepreneurial process. Information based on the trials of past entrepreneurial projects can be particularly useful as it reveals details about the local market, benefiting subsequent ventures. Through a formal model of entrepreneurial search characterized by information flows through networks, we hypothesize a diminishing-returns relationship between entrepreneurial information, in the form of births and deaths of entrepreneurial projects, and economic benefits in the form of employment growth. We leverage the natural experiment contexts of regional economies to explore the role of information as it varies across market scale. In addition, given that networks, an important channel for information, are most powerful and effective in localized settings, we use the regional socio-demographic variation to explore the role of networks defined by gender. We indeed find statistically and economically significant evidence for the information-growth relationship in terms of both market scale and gender, with larger positive employment effects in less dynamic markets and less-networked market contexts. After building the empirical case for the importance of information flows and networks, we conclude with policy implications with particular attention to broadening and deepening entrepreneurial ecosystems.

1 Introduction

The fundamental benchmark for economic growth is job creation. New establishment startups, almost all of which comprise enterprises of less than 10 employees, are responsible for over 1/3 of gross job creation in the United States. A further third of job creation occurs among establishments aged from one to five years. Thus the vast majority of job creation comes from new and young businesses.

Fresh entrepreneurial projects are constantly testing market frontiers in sectors from retail to manufacturing to services. The sheer volume of innovative startups is regularly cited for the US's continuing economic strength and job creation prowess. However, the declin-

ing dynamism of the entrepreneurial sector in the new millennium is an increasing area of concern, particularly in terms of its effects on macroeconomic job growth. Yet entrepreneurship is inherently local, leveraged most effectively in proximate business clusters (Saxenian, 1994).

Information is a critical component of the entrepreneurial process. By their success and even their failure, past entrepreneurial projects reveal information about the contours of the market landscape such as consumer demand, the accessibility of complementary business services, and the availability of feasible financing. Thus in addition to the direct benefit of generating jobs, the indirect information externality generated by the entrepreneurial process benefits future projects by reducing market uncertainty, improving the prospect for success, and culminating in a stronger local economy. This externality is developed in an informational networking model based on Leyden et al. (2014) linking networks and the information provided by establishment births and deaths to entrepreneurial projects' chances of success.

Based on the hypotheses emerging from the theoretical model, we leverage the natural experiments inherent in the spatial specificity of regional economies to discern empirically entrepreneurial information and its impacts on economic growth. We then extend the inquiry within such spatial units to explore the potential information transmission mechanisms within social networks formed by specific socio-demographic groups, in this case by gender, to understand such networks' impacts on regional entrepreneurial dynamism. Thus, similar to Roper et al. (2017), we theorize that spatially specific market-based information influences entrepreneurial activity via social networks but distinctly posit that entrepreneurs generate such information and that it is shared through socio-demographic networks, such as that defined by gender.

The local informational benefits from entrepreneurial activity are not uniform across all entrepreneurial projects. We hypothesize a diminishing-returns relationship, characterized by diminishing returns, between information increments from entrepreneurial projects and the economic payoffs in terms of stronger log-term job growth through improved entrepreneurial projects. This dynamic implies a relatively large return to the marginal entrepreneurial project in "thin" markets with less entrepreneurial activity compared with the marginal project in a highly dynamic market with a well-known market terrain.

In this research, we consider the diminishing return to information in two contexts. First, we evaluate this concept spatially, exploiting the regional variation in market scale to find evidence of relative diminishing returns as market thickness increases. We then consider the importance of specific social networks within each context. Leveraging the literature on gendered business networks, we explore gender variation in entrepreneurial activity within communities to evaluate the effects of flows of entrepreneurial information through social networks. A female entrepreneur entering a local network not only adds establishment-specific information for potential followers, the entrepreneur herself also incrementally adds a further node to the local women's business network. Early-stage entrants in relatively lesser-

developed "thin" networks may thus be particularly impactful, not simply in the information-revelation process of her business project but also by providing critical nodal foundations for subsequent local women entrepreneurs.

Using an empirical model based on a spatial equilibrium endogenous growth framework, we test the effect of entrepreneurial information through establishment dynamics and indeed find evidence of a decreasing-returns relationship between incremental entrepreneurial information and subsequent job growth. Our baseline spatial results suggest the information from entrepreneurial projects produces positive and diminishing returns, meaning entrepreneurial activity produces relatively large employment payoffs in thin markets where there is less business activity. Furthermore, in a given spatial context, entrepreneurial activity by women has higher job payoffs than parallel activity by men. This finding suggests that informational increments in relatively lesser developed social business networks have greater economic impact. The additional activity in thin markets adds to the network and thus enhances informational flows.

1.1 Information and Entrepreneurship

Entrepreneurs must amass, combine, and filter large amounts of information at each stage of the entrepreneurial process. Identifying a viable business idea requires some insight on an innovative new good or service or a valuable variation of a product already on the market. Entrepreneurs must recognize an unexploited market niche or an unmet consumer demand. They have to learn about market suppliers and business services available to complement their venture. Securing financing, finding a location, and establishing contact with clients all require a certain amount of information about competitors and the business community in general. As entrepreneurs learn more about the market, they can use the new information to continually gauge their prospects for success, better source their inputs, and make decisions regarding the growth and promotion of their business.

In addition to accessing and processing information about the market for their own venture, entrepreneurs also generate information as they carry out their business activities. Each entrepreneurial project, either by its success or failure, reveals information about the market (Bunten et al., 2015). A project may reveal a viable product, a successful innovation, consumer demand, supplier networks, or labor pools, as examples. Entrepreneurial creation thus sheds light on a specific combination of demand and supply characteristics in terms of feasibility. Success in terms of growth underscores the viability of that particular project's combination.

Yet a project failure may be equally valuable, in that it signals that a particular demand/supply combination does not work; knowing what path NOT to pursue is valuable business information in itself. In that sense, follower establishments build on the wreckage of unsuccessful projects to make themselves stronger. Information generated by the success and failure of past projects effectively creates a significant positive externality because it is

available to incoming entrepreneurs for the benefit of their forthcoming projects. Subsequent entrepreneurial projects will be carried out with more information on the local market and relevant industries. Entrepreneurs can imitate the successes of past projects and re-engineer the projects that failed. In this formulation, current entrepreneurship is a causal factor in determining future entrepreneurship and thus in creating sustained economic development, as game-theoretically formalized in Weiler (2000).

To more fully understand this role of entrepreneurs in economic growth, we must understand the ways in which uncertainty shapes their actions. Akerlof (1970) and Stiglitz and Weiss (1981, 1983) argue that uncertainty of quality limits the extent of markets, whether it be the market for cars, for loans, or for labor. Greenwald et al. (1984) theorize that uncertainty about future prices can exacerbate small price shocks and thereby deepen business cycles. Weiler et al. (2006) find that the social benefits of information provision are likely to exceed the private benefits, implying that market outcomes are likely to result in under-investment, particularly in thin markets. Microeconomic uncertainty can thus have macroeconomic effects. If entrepreneurs are crucial for the implementation of innovations, then uncertainty about their potential success can discourage participation and lead to a dearth of entrepreneurship and suboptimal growth.

Thus we view entrepreneurship primarily as a process of information revelation that is integral to economic growth. While entrepreneurs may seek to apply new technical knowledge to produce a new product or lower costs, they do so with uncertainty as to the eventual success of this application. In pursuing the implementation of an innovation, entrepreneurs reveal its viability to the marketplace, reduce uncertainty, and thereby encourage investment; others can follow the successful pioneer while sidestepping the pitfalls made clear by the failures.

Entrepreneurial information has a distinctly local characteristic in such a formulation (e.g. Weiler (2006)). The potential for business success is market-specific, both in its potential demand contours (e.g. for service industries) as well as more universally in its supply/cost character (i.e. labor, land, capital, insurance, among others). In regions with "thinner" markets–fewer openings, closings, and other business transactions–information on the potential of such markets will consequently be more limited. Such information gaps may themselves impede prospective entrepreneurs directly, but may also indirectly restrict business opportunity through higher perceived uncertainty by critical loan and insurance suppliers.

The statistical analogy is straightforward. Even if the underlying probability profiles of two potential projects are identical, having fewer data points in a given market heightens variance, which in turn suggests higher risks and thus greater cost premiums for loans and insurance even if the underlying probability of project success is the same. As first presented and empirically evaluated in Bunten et al. (2015), we thus see differences in market-specific entrepreneurial experience as driving geographical informational asymmetries, in the spirit of Akerlof (1970), which in turn can yield suboptimal local investment and growth (Weiler et al., 2006).

1.2 Theoretical Motivation

The information hypotheses can be structured by varying a model first proposed by Leyden et al. (2014). In the original model, more effective networks reduce costs resulting in an expanded search for inputs and improved prospects for success. Augmenting the model to more explicitly account for networks as well as market information generated by past entrepreneurial ventures motivates our hypotheses.

The entrepreneur, in exploring the optimal combination of inputs, must acquire information, procure resources, and choose production methods and strategies. These inputs, N, can be combined into sets represented by Nx1 vectors x ϵ $\mathbb{R}$. Also, assume the search space is partly determined by the informational environment. With better market information, entrepreneurs are able to more efficiently search for their inputs. Suppose, in local market i, there is an information production function that is increasing in establishment births, deaths, and their interaction

$$\lambda_i = \lambda_i(b_i, d_i) \tag{1}$$

and has the following properties:

$$\frac{\partial \lambda_i}{\partial b_i} > 0, \frac{\partial^2 \lambda_i}{\partial^2 b_i} < 0 \tag{2}$$

$$\frac{\partial \lambda_i}{\partial d_i} > 0, \frac{\partial^2 \lambda_i}{\partial^2 d_i} < 0 \tag{3}$$

The entrepreneur will use information to search for other inputs that optimize the entrepreneur's venture, sequentially expanding the search space such that

$$A_0 \subset A_1 \subset A_2 \subset ... \tag{4}$$

The entrepreneur's search is costly. Assume that this cost increases with the size of the search space and decreases with the quality of the entrepreneur's network and aggregate experience of its members. With each entrepreneurial venture, the aggregate entrepreneurial experience and the network itself expands with both new and deeper connections. These network ties, both strong and weak, provide important entrepreneurial information. Strong ties are associated with access to fine-grained information and tacit knowledge whereas weak ties provide novel information as they bridge between otherwise disparate networks (Elfring and Hulsink, 2003). Thus, network quality γ is a function of the heterogeneity of the entrepreneur's social ties and the past experiences they can share with her, s, which are themselves a function of establishment births and deaths within a particular network. Networks can also be considered gender specific,where male and female networks are separate, mutually exclusive,

and exhaustive. Thus men and women will face different costs to their search for inputs based on the development of their collective networks. Further, we expect that early nodes in the entrepreneurial network provide important foundational connections, more so than later nodes that add a relatively smaller increment of network value leading to the following assumptions:

$$\gamma_{gi} = \gamma_{gi}(s(b_{gi}, d_{gi}))\ \ g \epsilon \{m, f\} \tag{5}$$

and

$$\frac{\partial \gamma_{gi}}{\partial b_{gi}} > 0, \frac{\partial^2 \gamma_{gi}}{\partial^2 b_{gi}} < 0 \tag{6}$$

$$\frac{\partial \gamma_{gi}}{\partial d_{gi}} > 0, \frac{\partial^2 \gamma_{gi}}{\partial^2 d_{gi}} < 0 \tag{7}$$

If we assume that information can expedite and improve the procurement process, then the size of the search space is also affected by the local market thickness λ_i. This implies that in more dynamic spaces with stronger informational network channels, entrepreneurs won't have to search as far for the necessary inputs or, given a cost constraint, an entrepreneur in a thicker informational market could search further for inputs as shown in Figure 1. Thus, the size of the search space will be inversely related to market information λ_i. Letting A_t be the Lebesgue measure of the size of the search space A_t:

$$A_t = A(A_t) = \int_{x \epsilon A} \frac{x}{\lambda_i(b_{gi}, d_{gi})} dx \tag{8}$$

$$\frac{\partial A_t}{\partial b} < 0, \frac{\partial^2 A_t}{\partial^2 b} < 0 \tag{9}$$

$$\frac{\partial A_t}{\partial d} < 0, \frac{\partial^2 A_t}{\partial^2 d} < 0 \tag{10}$$

The costs of searching depend both on the size of the region and the effectiveness of the entrepreneur's network.

$$c_t = c(A_t|\gamma) \tag{11}$$

Costs are characterized by marginal costs and convex average costs with respect to A_t as shown with a second-order Taylor series expansion of the cost function evaluated at γ over the search area A_t:

$$\frac{\partial c}{\partial A_t} > 0, \frac{\partial^2 c}{\partial^2 A_t} \geq 0 \tag{12}$$

$$\frac{c(A_t|\gamma)}{A_t} \ni A\frac{\partial^2 c}{\partial A_t^2} - 2\frac{\partial^c}{\partial A_t} + 2\frac{c}{A_t} \tag{13}$$

As the entrepreneur's network becomes more effective, potentially due to an increase in entrepreneurial activity, costs decrease. As men likely have more effective networks compared to their female counterparts, suppose the that the male network, given by γ_m, is greater than the effectiveness of the female network γ_f The implication is that at any given level of costs, an entrepreneur with a more effective network benefits from greater efficiency and can explore a larger input space A_t.

$$\frac{\partial c}{\partial \gamma} < 0, \tag{14}$$

$$\frac{\partial^2 c}{\partial A_t \partial \gamma} < 0, \tag{15}$$

$$c(A_t \mid \gamma_m) < c(A_t \mid \gamma_f) \tag{16}$$

The relative size of the search space is important because entrepreneurship is inherently uncertain. The probability of success in A_t is unknown and, as a result, entrepreneurs rely on subjective estimates of the probability of success which increases with the entrepreneurs' search region. Assuming the M-dimensional set $K \epsilon \mathbb{R}^M$ describes the entrepreneur's knowledge set, the entrepreneur's subjective probability of success in region A_t is defined by the cumulative probability function $F(A_t \mid K)$.

$$F(A_t \mid K) \ni 0 \leq F(A_t \mid K) \leq 1 \tag{17}$$

and

$$F(A_t \mid K) < F(A_{t+1} \mid K) \tag{18}$$

To finance their venture, assume the entrepreneur enters capital markets and her access is bound by the expected value of her venture V^e where that value is defined as the product of the maximum value V of a successful venture and the probability of success.

$$V^e(V, A_t \mid K) = V * \hat{F}(A_t \mid K) \tag{19}$$

Her resource constraint is thus:

$$c(A_t \mid \gamma) \leq V^e(V, A_t \mid K) \tag{20}$$

Assume an entrepreneur optimizes their probability of success by choosing a region of size $A*$ subject to the budget constraint. The optimal solution will equalize costs with expected value, because the probability of success of the project increases with size of the search area.

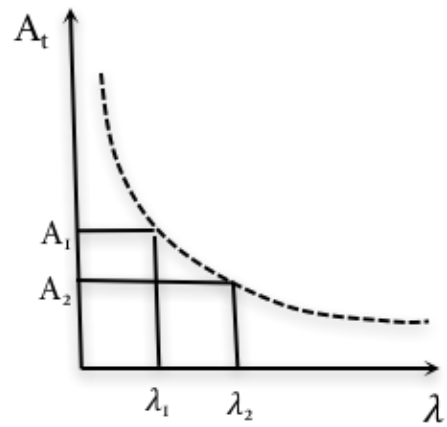
$$c(A_t \mid \gamma) = V^e(V, A_t \mid K) \tag{21}$$

Births and deaths thus affect the entrepreneurial ecosystem in a discernible manner that leads to empirically testable hypotheses, both in themselves and their interaction. Births and deaths contribute directly to the information set represented by λ, as well as to the evolution of network channels in subgroups represented by γ_g. As outlined in Bunten et al. (2015), however, simple births and deaths devalue the impact of their interaction. Markets with higher levels of births in the presence of more deaths emphasize the importance of market dynamism, where births and deaths together create a second-order effect above and beyond their first-order level impact. The significance of these interactive effects in Bunten et al. (2015) and the present study even when controlling for births and deaths individually indicate that such dynamism is indeed a crucial element of their informational-channeling role. Marginal effects will thus include both direct and interactive components when evaluating births and deaths.

Leveraging the model above, births should have an unambiguously positive impact on eventual job growth. In addition to the direct and immediate effect of new jobs associated with startups, births also indirectly enhance both the information environment λ and network effectiveness γ. Holding costs and other inputs equal, greater amounts of information and more developed network channels lead to a larger search area, and a consequent higher probability of projects' success. Aggregating across all establishments and projects at the regional level, a greater likelihood of entrepereneurial project success yields higher employment growth. Thus, establishment births should have a clear positive marginal effect on local job growth.

Deaths have competing effects, generating a more robust empirical test. As explicitly shown in the model, deaths too have eventual positive indirect λ information and γ network effects. Deaths, however, also result more immediately in a direct negative effect associated with the job losses from closure. Thus, the marginal impact of an establishment death will have have two competing elements. If the positive indirect information and network job effects are greater than the immediate and direct job losses, the total effect on success, and ultimately employment growth, will be positive in the long run. In that sense, deaths effectively have an especially high bar for positive job growth effects, where informational and network impacts

Figure 1: Marginal Effect of Information with Constant Costs



must be sufficiently strong to outweigh the self-evident immediate job losses with an employer establishment closure.

1.3 Market Scale

One of the primary predictions of the theoretical model is that market scale should have a substantive effect on employment returns via the search area. Markets with relatively little entrepreneurial activity such as those defined by smaller, remote, or rural communities are in a position to benefit considerably from each additional establishment birth or death, as noted by the increasing but diminishing returns to λ. Intuitively, thin informational markets get large benefits from just a few additional openings or closures, as each informational increment translates into relatively wide swaths of new understanding about previously unexplored entrepreneurial terrain that improve the search for intermediate inputs and infrastructure. Incremental births and deaths have a relatively high job growth payoff for the information those openings and closures produce as they help refine the entrepreneurial search and improve the prospects of subsequent entrepreneurial projects.

Ultimately, the effect of entrepreneurial information enhances startup activity and the probability of success culminating in stronger economic performance. Henderson and Weiler (2009) find that county startup rates positively influence future employment growth in the same and surrounding counties. The own county effect is stronger when it is a lower-activity county and has neighbors with relatively high startup rates. Startups thus have dynamic external effects–precisely what this view of entrepreneurship as information revelation would predict.

Thus, if the information revelation perspective is in fact relevant to the regional growth process, one would hypothesize that regions where births and deaths were significantly below a broader average would have high growth payoffs to entrepreneurial activity. Conversely,

regions which have dynamic entrepreneurial activity would have lower payoffs to additional births and deaths. Thus, in thin markets, we hypothesize that the marginal effect of an additional establishment birth or death on employment growth is quite large, and conversely, that the marginal effect of additional birth or death on employment growth in highly dynamic economies is relatively small. These propositions can be directly tested through marginal effects to an endogenous growth framework, as outlined in the empirical section below.

1.4 Gender Networks

One way information is shared, spreading to new entrepreneurs for use in their project is through networks. Following Hervas-Oliver et al. (2017), we posit that interpersonal and, by extension, inter-firm networks are a key learning mechanism for new ventures and play a significant role in reducing transaction costs. That is, access to social connections can play a role in overcoming information deficits about the market, enhance the search for inputs, and influence an entrepreneur's prospects for success (Bauernschuster et al., 2010). These business networks can evolve along many dimensions, both economic—such as by sector or industry— and socio-demographic, such as by gender. This paper explores the network informational asymmetries between male- and female-owned businesses and their impacts on job growth.

As a result of long-standing social institutions such as male-dominated professional networks and historical gender norms, women may find it difficult to integrate themselves into these supportive networks. Most entrepreneurs, especially most older, experienced entrepreneurs, are men. As a result, the understanding of the market is largely based on the male experience, told from the male perspective, and shared mostly among men. Consequently, the marginal male-owned firm not only adds relatively little information to the network but its additional node adds relatively little to an already well-developed network. Thus, for men, the network γ_m has reached diminishing returns to births and deaths as captured by Equations (6) and (7).

Comparatively, women entrepreneurs enter the market at a network disadvantage. Only in recent decades have women become a significant share of entrepreneurs and business owners. Even now women own less than one-third of firms in the United States and account for just 10% of sales (U.S. Department of Commerce, 2010). The birth rate and death rate among women-owned businesses has historically been and remains much lower than that for males. As consequence of the low level of entrepreneurial activity among women, new women entrepreneurs enter a relatively thin informational market with only a skeletal network, resulting in greater uncertainty for any given potential project. Incoming women entrepreneurs have fewer role models and mentors and thus limited information about the local market that comes from past projects. Even beyond their access to market-based information, weak networks may additionally disadvantage women in their access to finance, supplier networks, and other components of business that benefit from interpersonal relationships.Thus social networks, which theoretically reduce transactions costs and thereby increase economic ef-

ficiency, may actually be a barrier for women entrepreneurs (Weiler, 2000). In such an network environment, we assume $\gamma_f < \gamma_m$ and, as consequence, women face higher search costs, a subquently smaller search area, and a lower probability of success.

The information asymmetries could discourage new businesses led by women entrepreneurs, but at the same time from both an information and network perspective, each of their projects is all the more valuable. That is, with relatively little information available on women entrepreneurs alongside a relatively thin network, pioneering females improve network effectiveness in relatively large increments. In addition, each project—even a failure—adds a potential node to the female entrepreneurial network. Even if only the most promising female-led projects overcome the obstacles and succeed in the marketplace, their projects are all the more likely to pioneer the way for future entrepreneurs, both by informing their followers and by creating critical foundational nodes for their network. The combined effect of such female pioneers should result in larger regional employment effects than entrepreneurial increments to the already-information-thick and well-networked male ecosystem. Thus, compared to men, the marginal effect of an additional female-led project, $\frac{\partial \gamma_f}{\partial b_f}$ or $\frac{\partial \gamma_f}{\partial d_f}$, generates a larger increment of network effectiveness.

2 Empirical Framework

To empirically test the effects of market information λ and networks γ on local economic growth, their role must be placed in the broader context of regional economic growth dynamics. The empirical model for this research relies on that of Bunten et al. (2015), expanded to consider these effects as they relate to market scale and gender. They consider geographic information asymmetries using a spatial-equilibrium endogenous growth model. Their model is influenced by Roback (1982) in that equilibrium results from households and firms optimizing utility and profits, respectively, across space as well as Stephens et al. (2013) in that they consider the factors that drive the supply and demand for labor. Households choose their location to maximize utility which is a function of several factors that vary regionally including rent and amenities. Attractive regions will feature higher rent in equilibrium such that no household has incentive to move. Firms locate production to maximize profit which is a function of wages and labor productivity among other factors. Structural factors taken together with household and firm behavior determine wages, rent, and labor market dynamics.

Households maximize utility over space by choosing to reside in a particular location, indexed i. The optimal choice offers the best combination of amenities, local characteristics, rent, and expected wages given the skills of the household members. In the long-run, optimizing behavior will result in equilibrium utility such that no household has incentive to relocate. In the medium-run, households will move according to the difference in relative utility across locations i resulting in changes to labor supply

$$\Delta\, Labor\, Supply_i = L_s(U_i - U - M_i) \tag{22}$$

where labor supply (L_s) is increasing in relative local utility given by $U_i - U$ and M_i summarizes moving costs.

Firms consider the potential set of locations for production, indexed i, based on several factors including relative wages, labor availability and productivity, market access, the cost of inputs, and positive externalities from agglomeration. Firms will choose the location that maximizes expected profit π. In the long-run, no firm will have a profit incentive to enter or relocate. In the interim, firm entry and migration will determine changes in labor demand

$$\Delta\, Labor\, Demand_i = L_d(\pi_i - \pi) \tag{23}$$

where the change in labor demand (L_d) is increasing in relative local profit given by $\pi_i - \pi$.

The above Equations 22 and 23 describing labor force dynamics can be summarized in a reduced-form equation that describes the relationship between regional employment growth and the factors that drive household and firm behavior. Local characteristics such as natural amenities and the accessibility of metro areas will affect local labor supply. Similarly, certain local attributes that affect firms' profitability, such as the skills of labor force and industrial composition, will determine labor demand. The reduced-form equation can be described generally as follows

$$Employment\, Growth_i = G(B_i,\, D_i,\, E_i,\, IN_i,\, PD_i,\, PG_i,\, HC_i,\, MA_i,\, A_i,\, DM_i) \tag{24}$$

where employment growth in county i is a function of entrepreneurial information and networks via the establishment birth rate (B_i), death rate (D_i), and their interaction, employment conditions (E_i), income (IN_i), population density (PD_i) and growth (PG_i), human capital (HC_i) , the median age (MA_i), natural amenities (A_i), and distance to metro areas (DM_i).

If entrepreneurial projects do in fact enhance networks and provide a positive information externality that benefits subsequent entrepreneurs and ultimately supports local employment growth, the combined effect of entrepreneurial activity, measured by the establishment birth rate (B_i) and death rate (D_i), should be positive in support of our fundamental hypothesis (Hypothesis 1). Further, if there are diminishing returns to market information, the marginal effect of entrepreneurial activity should be quite large in places with relatively little entrepreneurial activity and conversely, the marginal effect of entrepreneurial activity should be small in more dynamic economies (Hypothesis 2). The diminishing returns to information based on market scale should also hold in the gendered market segments (Hypotheses 3a and 3b). Last, if women are exposing lesser-known market terrain, the marginal

Table 1: Information Theory, Hypotheses, and Empirical Testing

Hypothesis	**Empirical Implication**
(1) Entrepreneurial projects (establishment births and deaths) generate a positive effect on employment growth.	The marginal effects of establishment births and establishment deaths will both be positive.
(2) The marginal effect of entrepreneurial activity is relatively large in less dynamic economies compared to the marginal effect of entrepreneurial activity in highly dynamic economies.	The marginal effect of an establishment birth (death) will be decreasing on the interval +/- three standard deviationsf from the mean establishment birth (death) rate.
(3a) The marginal effect of male entrepreneurial activity is relatively large in less dynamic economies compared to the marginal effect of male entrepreneurial activity in highly dynamic economies.	The marginal effect of a male-owned establishment birth (death) will be decreasing on the interval +/- three standard deviations from mean male-owned establishment birth (death) rate.
(3b) The marginal effect of female entrepreneurial activity is relatively large in less dynamic economies compared to the marginal effect of female entrepreneurial activity in highly dynamic economies.	The marginal effect of a female establishment birth (death) will be decreasing on the interval +/- three standard deviations from the mean female-owned establishment birth (death) rate.
(4) The marginal effect of female entrepreneurial activity is relatively large compared to the marginal effect of male entrepreneurial activity.	The marginal effect of a female establishment birth (death) on the interval +/- three standard deviations from the mean mean female-owned establishment birth (death) rate will be greater than the marginal effect of a male-owned establishment birth (death) on the interval +/- three standard deviations above (below) the mean male-owned establishment.

effect of a woman-owned business should be larger than the marginal effect of an additional male-owned business (Hypothesis 4).

Based on the theoretical emphasis on γ and λ, the focal variables, births, deaths, and their interaction, are examined first as gender-blind variables and then in a gendered context. Following the gender-blind specification, the second specification uses only male-owned establishment dynamics in combination with the remaining control variables. Symmetrically, the third specification uses only the birth rate, death rate, and interaction term for only female-owned firms. In the fourth combined specification, we include both the male- and female-owned establishment dynamics.

2.1 Endogeneity

Including measures of market information and network using entrepreneurial activity in a model of employment growth has the potential for endogeneity. Employment growth may result from successful entrepreneurs growing their businesses and adding employees. However, it is equally plausible that entrepreneurs themselves respond to an expanding economy, pursuing their ventures on signs of economic growth. Thus, growth and entrepreneurial activity may each reinforce the other, and/or respond to an exogenous factor that leads to both employment growth and increased entrepreneurial activity simultaneously. One such factor that could enhance both entrepreneurship and job employment growth is the entrepreneurial ecosystem that includes entrepreneurship-supporting organizations and institutions and business culture. As substantiated in the cited work by Saxenian (1994) and also many other studies, the local entrepreneurial ecosystem is strongly related to both past

and future entrepreneurial choices as well as employment growth.

The likely endogenous relationship, which could be driven by circular causation or under-accounting for ecosystem factors that are correlated with employment growth and our focal variables, makes it difficult to empirically isolate the effect of entrepreneurship on growth. Following a well-worn trail negotiating such statistical conundrums (e.g Sander (1992)), we use an instrumental variable strategy to address the possible endogenous variables. In doing so, we seek to clearly identify the causal relationship between entrepreneurship and regional employment growth.

The gender component and the unique measures of establishment births and deaths using NETS data present distinct challenges to an IV strategy. The measures of male and female entrepreneurship are likely to each require their own set of instruments, since the surge of women entrepreneurs in recent decades represents a different trend than the long-standing presence of male business owners (Conroy and Weiler, 2016). The NETS data presents its own set of hurdles because it is a broader measure of establishment births than that defined by Census sources, which count only new employer businesses (see appendix) as births. Using NETS, the birth rate includes both new employer and non-employer businesses. Given the variety of new business activity included, finding an orthogonal relationship in an instrument—where an exogenous variable is systematically related to entrepreneurship but unrelated to growth—is especially challenging.

The instruments for our measures of entrepreneurship are primarily deep lags of entrepreneurial and small business activity. Historically high levels of entrepreneurship are a signal of an entrepreneurial culture that likely persists over time leading to more business activity in the future. Usefully, in contrast, historical entrepreneurship likely has no relationship to future employment growth. Given these characteristics, our instruments, specifically the proprietor's share of employment (1979) and the share of employment in small businesses (1974), have foundational utility for disentangling the relationship between entrepreneurship and employment growth.

However, the deeps lags of entrepreneurial activity are not adequate instruments by themselves. Therefore, we also include the employment-residents ratio (1980) and the female employment-population ratio (1950) (Haines, 2010). The lagged employment-residents ratio indicates a region that was relatively employment dense, which in turn would have crowded out demand for new entrepreneurial niches while also stifling the supply of potential entrepreneurs through the density of relatively stable wage-and-salary jobs. The female employment-population ratio corresponds to regions that may have had relatively significant male job losses, which is likely to have negative repercussions on the local business environment including those seeking niches to start enterprises.

Given the noted differences in the evolution of male- versus female-entrepreneurship, the measures of female entrepreneurship, not surprisingly, require a separate set of instruments. The instruments used for our gender-blind and male measures entrepreneurship are ineffective for women. Women likely faced unique barriers to entry based on historical gender roles

including a male-dominated business network. The evolution of women's role in the labor force during the last 60 years, alongside a much larger socio-cultural shift in women's rights, roles, and opportunities, clearly created the preconditions for women's advancement as business owners. While the cultural shift conceivably lowered barriers to female entrepreneurship, it is likely unrelated to future employment growth—thus suggesting a potentially valuable category of instrumental variables (IV).

The twin developments of women's role in the labor force alongside broader socio-cultural shifts indeed prove to be fertile ground for the needed IVs. Growth in female labor force participation (1950-1970) and the divorce rate (1980) show themselves to be particularly good instruments for women's entrepreneurial activity in our model of employment growth (Haines, 2010). Increases in female labor force participation may signal growing opportunities in more stable wage-and-salary positions and also as business owners. Since most entrepreneurial financing is derived through family networks, a higher divorce rate may cut off critical credit, especially during an era when men controlled most assets and women had remarkably little recourse to formal credit channels.

In the final statistical models, we combine the growth in female labor force participation and divorce rate with the proprietor's share of employment in 1979 and the share of employment in small businesses in 1974 for the IV mix. In the fourth regression,which requires additional instruments, we add the share of female headed households in 1970 as another indicator of changing gender dynamics, and the share of the population age 25+ with four years or more of college in 1980. This educational attainment variable similarly signals both shifts in labor force quality as well as changing socio-cultural benchmarks; the bachelor's degree itself is a particularly important threshold for both male and female entrepreneurship (Conroy and Weiler, 2015). Together, the variables prove to be strong instruments in the first-stage results.[1]

3 Empirical Model and Data

The empirical strategy follows directly from the reduced-form solution summarized by Equation 24, we estimate Equation 4 for 3072 counties or county equivalents in the contiguous United States. Counties typically feature a primary city, usually the county seat, that forms the industrial, population and political center for the area. While the city may be integrated socially and economically with adjacent areas, the primary city is typically the most relevant employment center which anchors the nearby population thus making a relatively small cohesive economic unit. As the smallest feasible unit of observation for this study, we focus on counties in the contiguous United States.

[1] First-stage results are available from the author upon request.

$$
\begin{aligned}
Employment \quad Growth_i = \beta_0 + +\beta_1 * Births_i + \beta_2 * Deaths_i + \beta_3 * (Births_i * Deaths_i) \\
+\beta_4 * Employment_i + \beta_5 * Income_i + \beta_6 * Lagged\,Emp\,Growth \\
+\beta_7 * Predicted\,Emp\,Growth_i + \beta_8 * Human\,Capital_i \\
+\beta_9 * Population\,Growth_i + \beta_{10} * Population\,Density_i + \beta_{11} * Median\,Age_i \\
+\beta_{12} * Amenities_i + \beta_{13} * Distance\,to\,Metro_i + \epsilon_i
\end{aligned} \tag{25}
$$

One unique aspect of this research is the data source for several of our key variables. We use the National Establishment Time Series (NETS) to calculate the dependent variable, employment growth, as well as the establishment birth rates and death rates, the key explanatory variables. The NETS database originates with Dun & Bradstreet and is compiled into a time series by Don Walls & Associates who also clean and update the data with each year's release. The NETS database tracks U.S. establishments annually in detail from the first year they are active to their last year.

The employment growth rate from 2000 to 2007 calculated using NETS is the dependent variable for the analysis. The 2000 to 2007 period is advantageous because it captures a complete business cycle, spanning the (mostly) expansionary period that peaked in December 2007 (NBER) and comes before the possible structural shifts that accompanied the Great Recession. It is also consistent with using the 2000 Decennial Census for several explanatory variables. The NETS employment data deviates from some common sources in that it measures employment more broadly than government agencies that typically use non-farm payroll employees. NETS spans all sectors including farming and includes all forms of employment attached to a location including the owners themselves. Despite the methodological differences, we find that NETS employment growth for the period is close to that using data from the Bureau of Economic Analysis. See the data appendix for details.

The NETS database is advantageous for this analysis primarily because it is possible to disaggregate the birth rate and death rate for women-owned or managed establishments. Using the establishment level data in NETS we calculate county-level aggregates for the establishment birth rate and death rate in total and by gender. [2] The establishment birth rate and death rate include both nonemployer and employer establishments making the measures distinct from comparable statistics available from the Census Business Information Tracking Series. Including nonemployers also implies that NETS measures entrepreneurship more broadly–capturing early-stage business openings and closings that reflect more subtle entrepreneurial experiments than are captured by more obvious employer establishments.

These data, particularly the data capturing establishment births, deaths, and their interaction, combined with the model given in Equation 4 provide the basis for analyzing the theoretical relationship between the market information, networks and employment growth. We expect this relationship exhibits diminishing returns in the context of market scale and

[2] Please see appendix for details on definitions and methodology.

gender. Specifically, we expect that in more dynamic economies and more developed networks the incremental effect of an additional entrepreneurial project will be smaller than in less dynamic and less networked segments.

Births and deaths are each inputs into market information and network effectiveness. Therefore, the specification includes the establishment birth and death rates each separately as well as their multiplicative relationship. Conceptually, this multiplicative relationship, which can be thought of as squaring the informational components, is comparable to a quadratic term in that it yields a nonlinear effect to birth and death levels.[3] Yet the interaction is one dimension richer, in that it also isolates the likely informational interplay between births and deaths in generating a richer information set. To determine whether there is empirical evidence of diminishing returns, we consider both the sign and significance of our focal variables, including their interaction, as well as evaluate the marginal effects.

If the marginal effects of our core informational sources, namely births and deaths, are decreasing across a range of entrepreneurial activity, then the empirical results are consistent with the motivating theory. Such a finding implies that there are diminishing returns, in terms of employment growth, to entrepreneurial information. We then compare these marginal effects across gender with the expectation that women-owned establishment births and deaths generate larger marginal effects because of the relative lack of market information and established based on more limited female entrepreneurial experiences. Table 1 summarizes these hypotheses and empirical assessment.

The remaining explanatory variables follow Deller et al. (2001), Huang et al. (2002), Rappaport (2007), Acs and Armington (2006), Stephens and Partridge (2011) as well as the more recent Stephens et al. (2013) and Bunten et al. (2015). First, to assure that we measure the effect of entrepreneurial projects on employment growth apart from any underlying trends, we include lagged employment growth, as well as the log of employment in 2000, and historical population growth. Such variables control for the initial conditions in each county that are important drivers of subsequent regional economic conditions (Huang et al., 2002). Additionally as in Partridge et al. (2009) and Bunten et al. (2015), we include a measure of predicted employment growth based on the county industrial profile and the national growth trend of those industries. The variable thus controls for any local employment trends that may reflect regional industrial concentrations in industries that expanded or contracted nationally during the study period. For each county, the predicted employment growth is equal to the product of the county's initial industry shares s_{ij} and its respective national growth rate G_j for the period 2000-2007 and summed together: $D_i = \sum_j G_j * s_{ji}$ where industry employment shares are calculated from the County Business Patterns for each three digit NAICS sector and the BEA-REIS for government.

Human capital is an important factor determining entrepreneurial outcomes (Conroy and

[3] Alternatively, the baseline genderblind regressions using the establishment birth rate, establishment death rate, and their repective quadratic terms yields the diminishing returns posited by the theoretical motivation. However, using the interaction of births and deaths in place of squared terms better suits are theoretical priors and performs more consistently in the empirical analysis.

Weiler, 2015) as well as economic growth at the county-level (Beeson et al., 2001) and in labor market areas (Thompson et al., 2006). We use several measures of human capital that incorporate the insights from Florida (2002) on the importance of the creative class. The creative class, those workers engaged in creative thinking and processes, can enhance the productivity in a region by leading innovation and attracting businesses looking for a talented workforce. The human capital variables in the analysis thus include the share of the population with a bachelor's degree as well as those employed in two particular subsets of the creative class, the arts and high human capital occupations. Artistic occupations include those in the performing, applied, and fine arts. High human capital occupations are those in highly skilled and creative occupations such as engineering, architecture, and computer science. We also include the median age of the population as older populations are found to be more entrepreneurial, perhaps partly because they've acquired more professional experience.

Metropolitan areas provide many benefits from agglomeration. Access to amenities such as theaters, museums, and universities combined with dense and diverse business centers and a large population provide the ideal circumstances to generate positive externalities. These benefits, however, accrue to communities nearest to metropolitan areas. We include several coordinate-based measures of distance to the nearest MSA centroid to capture these benefits as they diminish with distance. To further control for agglomeration, we include the tract-weighted population density. Scenic locations with moderate climate also tend to host footloose entrepreneurs who value natural amenities (Deller et al., 2001; Rappaport, 2007). We include the natural amenity score provided by United State Department of Agriculture-Economic Research Service. Places that feature mountainous or an otherwise scenic landscape with mild winters and cool summers rank the highest.

Table 2: Summary Statistics

Variable	Mean	Std. Dev	Min	Max
Emp Growth, 2000-2007	3.9143	12.4214	-81.6092	122.2889
Birth Rate, 1998	7.7591	3.3240	0.0000	66.6667
Death Rate, 1998	6.7664	1.7409	0.0000	66.6667
Female Birth Rate, 1998	1.4995	0.7253	0.0000	12.2087
Female Death Rate, 1998	0.5585	0.2763	0.0000	8.4567
Nonfemale Birth Rate, 1998	6.2596	2.6971	0.0000	66.6667
Male Death Rate, 1998	6.2078	1.6043	0.0000	66.6667
Predicted Employment, 2000-07	6.2285	3.6193	-20.7134	87.2277
Emp Growth, 1990-2000	22.2327	20.5797	-39.3747	767.2035
Log Employment, 2000	12.3657	1.6822	4.5539	15.5126
Log Income, 2000	10.5546	0.2798	8.0287	11.3859
Density, 2000	6.4957	15.4140	0.0001	113.5345
BA Share, 2000	25.9645	9.8511	4.9205	60.4820
HC Share, 2000	24.6112	7.1381	0.0000	52.9723
Arts Share, 2000	1.2500	0.8109	0.0000	6.6721
Pop Growth 1950-1960	0.3901	0.4795	-0.4228	3.7112
Median Age, 2000	35.2095	3.1995	20.6000	54.3000
Amenity Score	1.2963	3.3467	-6.4000	11.1700
Distance to MSA	0.3040	0.3725	0.0000	4.3409
Marg dist MSA > 250k	0.2739	0.7735	0.0000	8.9237
Marg dist MSA > 500k	0.3369	0.8739	0.0000	9.3394
Marg dist MSA > 1M	0.4018	0.9614	0.0000	8.3617

Values are employment-weighted.

4 Results

We report OLS and IV results for the gender-blind, male, female, and combined specifications in Table 3. For interpretive ease, we center births and deaths for all regressions, and use the centered terms to create the interaction. All regressions are employment weighted and include state fixed effects. The dependent variable is the percent employment growth from 2000 to 2007. Though the table includes the full set of explanatory variables, the discussion to follow focuses on the key variables, namely the establishment birth and death rates and their interaction in aggregate and by gender.

4.1 Results: Market Scale

Before considering the specific coefficient estimates, we consider the appropriateness of the OLS specification by pursuing an IV analysis (detailed in the Appendix) to assess the endogeneity of the key entrepreneurial variables: births, deaths, and their interaction. While endogeneity is a concern in the analysis, theory and intuition are only limitedly helpful, perhaps even misleading, in resolving the issue, and we thus rely on a careful statistical approach. Based on the first-stage test of weak-identification, the instruments are strong for births, deaths, and the interaction. The relatively high Cragg-Donald statistic also provides evidence of strong instruments. Hansen's J statistic suggests that the instruments are exogenous. Last, we cannot the reject the null of exogenous regressors based on the GMM distance test. The diagnostic results taken together are evidence that our measures of entrepreneurial activity and employment growth are not endogenous. We thus choose to focus the OLS results for the following discussion on the gender-blind, male, and female specifications.

The gender-blind results support the fundamental hypothesis that the frequency of entrepreneurial projects—as measured by establishment births, deaths, and their product—have a positive and significant effect on local employment growth. The coefficients on the establishment birth rate, and perhaps more notably, the death rate are both positive and strongly significant, while the coefficient on the interaction term is negative and significant. As expected, new establishments are linked to employment growth, but the positive link between establishment deaths and employment growth is consistent with a positive informational effect. This positive effect is all the more remarkable because a death directly signifies employment losses with the establishment closure. The fact that deaths nevertheless have a longer-term positive employment effect over and above the direct negative effect of an establishment closure emphasizes the relative strength of the informational role.

Table 3: Employment Growth 2000-2007

			Obs=	3072			Obs=	3072			Obs=	3072			Obs=	3072
			R^2 =	0.6459			R^2 =	0.6426			R^2 =	0.6283			R^2 =	0.6505
			FE=	State			FE=	State			FE=	State			FE=	State
			IV=	No			IV=	No			IV=	No			IV=	NO
	Coef.	Robust SE	P>|t|	Coef.	Robust SE	P>|t|	Coef.	Robust SE	P>|t|	Coef.	Robust SE	P>|t|
C Birth Rate, 1998	1.1489	0.1210	0.000										
C Death Rate, 1998	1.1565	0.1919	0.000										
C B*D, 1998	-0.0930	0.0224	0.000										
C Male Birth Rate, 1998				1.2157	0.1307	0.000				0.8367	0.1217	0.000
C Male Death Rate, 1998				1.4124	0.2069	0.000				1.2167	0.2178	0.000
C Male B*D, 1998				-0.0980	0.0277	0.000				-0.0715	0.0263	0.007
C Female Birth Rate, 1998							6.1603	0.5691	0.000	3.1313	0.5640	0.000
C Female Death Rate, 1998							3.3178	0.8183	0.000	-0.1392	0.7912	0.860
C Female B*D, 1998							-3.8747	0.4910	0.000	-2.2825	0.4449	0.000
Demand Shock, 2000-07	0.1656	0.0653	0.011	0.1703	0.0655	0.009	0.2114	0.0662	0.001	0.1592	0.0649	0.014
Emp Growth, 1990-2000	0.1517	0.0328	0.000	0.1559	0.0336	0.000	0.1447	0.0335	0.000	0.1425	0.0319	0.000
Log Employment, 2000	0.4560	0.3753	0.224	0.2226	0.3812	0.559	1.1991	0.3749	0.001	0.5710	0.3780	0.131
Log Income, 2000	-14.1845	2.9128	0.000	-15.0376	2.9311	0.000	-16.9575	2.8418	0.000	-13.3215	2.8455	0.000
Density, 2000	0.0596	0.0390	0.127	0.0577	0.0399	0.148	0.1019	0.0331	0.002	0.0655	0.0380	0.085
BA Share, 2000	-0.2468	0.1199	0.040	-0.2646	0.1203	0.028	-0.2317	0.1189	0.051	-0.2227	0.1184	0.060
HC Share, 2000	0.5376	0.2123	0.011	0.5737	0.2157	0.008	0.5377	0.2104	0.011	0.4894	0.2058	0.017
Arts Share, 2000	-0.2992	0.8979	0.739	-0.1806	0.9091	0.843	-0.9557	0.7804	0.221	-0.4122	0.8814	0.640
Pop Growth 1950-1960	-1.5670	0.7522	0.037	-1.6262	0.7512	0.030	-0.3981	0.7065	0.573	-1.5044	0.7501	0.045
Median Age, 2000	-0.3994	0.1055	0.000	-0.3700	0.1056	0.000	-0.3560	0.1062	0.001	-0.4047	0.1047	0.000
Amenity Score	-0.0903	0.2087	0.665	-0.0895	0.2120	0.673	-0.0577	0.2084	0.782	-0.1305	0.2043	0.523
Distance to MSA	-0.5706	0.6405	0.373	-0.4808	0.6421	0.454	0.1155	0.6427	0.857	-0.5393	0.6299	0.392
Marg dist MSA > 250k	-0.2126	0.3180	0.504	-0.2720	0.3198	0.395	0.0236	0.3231	0.942	-0.1021	0.3124	0.744
Marg dist MSA > 500k	0.3414	0.2322	0.142	0.3598	0.2336	0.124	0.0558	0.2392	0.816	0.3147	0.2324	0.176
Marg dist MSA > 1M	0.5559	0.2888	0.054	0.5112	0.2924	0.081	0.4658	0.2902	0.109	0.5864	0.2827	0.038
_cons	156.327	28.17g	0.000	132.6158	28.8432	0.000	144.2213	27.9576	0.000	107.5734	28.1760	0.000

Using the centered birth rate and death rate allows for straightforward interpretation. In a county with a mean death rate, equal to zero after centering, the marginal effect of a one unit increase from the mean birth rate is 1.15 percentage points in employment growth over the subsequent period. Symmetrically for deaths, in a county with a mean birth rate, the marginal effect of a one unit increase from the mean death rate is 1.16 percentage points in employment growth. Thus consistent with our theoretical motivation based on a positive information externality, both births *and* deaths alike generate positive employment effects in the typical local economy. To give a sense of magnitude, in a county with the average 50,000 employees in 2000, a one unit increase in the birth rate would correspond to 50 additional businesses. These additonal 50 businesses would correspond to just over one percentage point additional employment growth from 2000 to 2007.

In addition to the positive effects of entrepreneurial dynamism, the results also demonstrate the importance of market scale. Given that births are interacted with deaths, effectively squaring our two information components, the marginal effect of the birth rate will vary with the establishment death rate. The negative coefficient on the multiplicative term between births and death alongside the positive coefficient on the birth rate is conceptually similar to interpreting a quadratic specification in that it signals a positive but decreasing relationship between entrepreneurial information from establishment births and employment growth. Our result is comparable to Roper et al. (2017) who use levels and squares of their variables measuring local knowledge sources and find a nonlinear, decreasing-returns relationship with innovative outputs by firms.

Table 4 and the accompanying Figure 1 display the marginal effect of the establishment birth rate across a range of establishment death rates three standard deviation around the mean. The plotted line with a downward slope, equal to the coefficient on the interaction term of -0.09, demonstrates the importance of entrepreneurial dynamism. On this interval, the effect of an increase in the establishment birth rate on employment growth is largest and positive in economies with a below average death rate and decreases thereafter in more dynamic economies. Similarly, Table 5 and Figure 2 demonstrate that the marginal effect of the death rate on employment growth is largest in counties with low establishment birth rates and decreases as economies become more actively entrepreneurial. That is, the marginal effects of a birth and death are higher in thinner, less-dynamic counties compared with the effects in thick, dynamic markets suggesting that market scale is key to understanding the incremental informational benefits of entrepreneurship.

Relative changes in entrepreneurial activity generate economically significant changes to regional employment outcomes. The fact that establishment openings generate jobs is not surprising; the fact that closures are equally constructive in creating job growth is remarkable. Furthermore, the impacts of a given opening or closure depend inversely on the thickness of their entrepreneurial environment. A new, pioneering firm exposes a relative wealth of information in thin markets. Comparatively, in a dynamic market with many closings and openings, a new firm adds only a slim margin of information about already well-known market terrain.

Table 4: Marginal Effects of the Establishment Birth Rate on Employment Growth

Establishment Death rate	dy/dx	SE	P>|t|
-3 SD	1.94	0.25	0.000
-2 SD	1.67	0.19	0.000
-1 SD	1.41	0.15	0.000
Mean	1.15	0.12	0.000
+ 1 SD	0.89	0.12	0.000
+2 SD	0.62	0.15	0.000
+3 SD	0.36	0.20	0.070

Figure 2

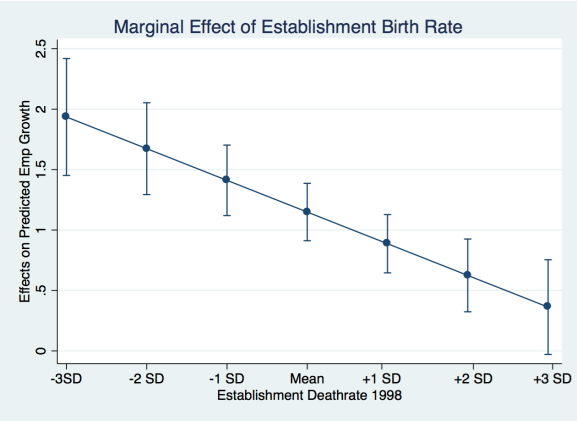
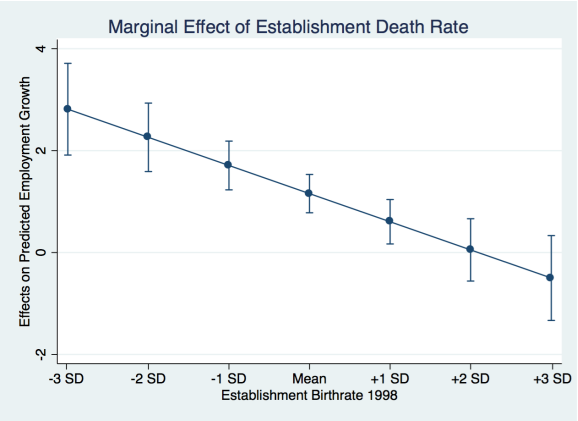


Table 5: Marginal Effects of the Establishment Death Rate on Employment Growth

Establishment Birth rate	dy/dx	SE	P>|t|
-3 SD	2.81	0.46	0.000
-2 SD	2.26	0.34	0.000
-1 SD	1.71	0.24	0.000
Mean	1.16	0.19	0.000
+1 SD	0.60	0.22	0.007
+2 SD	0.05	0.31	0.867
+3 SD	-0.50	0.42	0.239

Figure 3



4.2 Results: Male and Female Specifications

The gendered results are reported in the Tables 3 and 7. As in the previous section, before discussing the specific estimates, we consider the appropriateness of the OLS specification based on parallel analysis of an IV approach. The diagnostic results for the separate male and female IV specifications are substantively similar. In both cases, the first-stage tests of weak identification suggest that our instruments are strong across the establishment birth rate, death rate, and their interaction. The Cragg Donald statistic is relatively high in the male equation and sufficiently high in the female regression, further suggesting strong instruments. Hansen's J statistic indicates that the instruments are also exogenous in both equations. Lastly, the GMM distance test suggests that both male-owned and female-owned entrepreneurship measures are not endogenous. Given the strong instruments and statistical evidence that the focal variables are not endogenous, we focus on the OLS results in the following discussion. For reference, IV results are shown in Table 7. With a few exceptions these results largely mirror those in the preferred OLS model, especially in the gender-blind and male models where the instruments are strongest.

Generally, the pattern of results is similar across the male and female specifications and consistent with the gender-blind results from the previous section. The establishment birth rate is positive and strongly significant as is the death rate. The coefficient on the interaction term is negative and strongly significant, again highlighting the second-order effect that creates diminishing returns to entrepreneurial information. In support of the information hypothesis, there is a positive effect from births *and* deaths that contributes to subsequent regional employment growth.

As in the previous section, the marginal effects for each gender help clarify the relationship of our gendered measures of entrepreneurship to growth. The effect of a one-unit increase in the male-owned establishment birth rate in the average county is a 1.22 percentage point increase in employment growth over the subsequent period. Again, however, the marginal effect varies with the establishment death rate via the interaction term. The marginal effect is higher in less dynamic counties as indicated by the negative coefficient on the interaction term. Effectively, if we were to compare the effect of a one unit increase in the birth rate across two counties, one with average entrepreneurial dynamism and one relatively less dynamic, the thinner market would benefit from an additional tenth of a percentage point in employment growth.

Similarly, the marginal effect of an increase in the male-owned establishment death rate is 1.41 percentage points in the average county. As before, the marginal effect is larger in less dynamic counties. The dinimishing effect of a death is again determined by the coefficient on the interaction term, which indicates that that the informational business failure is larger is more valuable in counties with below average entrepreneurial activity measured by births. Thus the marginal effects of the the male-owned establishment birth rate and death rate trend are decreasing in scale in the same way as shown in Figures 1 and 2.

The marginal effects of the female owned establishment birth and death rates follow the same pattern, although are larger in magnitude. The marginal effect of the establishment birth rate is 6.16 percentage points in employment growth in the average county, while marginal effect of an increase in the establishment death rate is 3.32 percentage points in employment growth. These effects are substantively larger than the gender-blind and male-owned variations, yet fit with overall trends for female-owned businesses. Recall that a one unit increase in the female-owned establishment birth rate is equivalent to roughly 50 additional businesses. Further consider that women-owned businesses are concentrated in rapidly expanding industries like healthcare and education. These additional, potentially high-growth, businesses correspond to 6 percentage points, less than half of one standard deviation, of additional employment growth over the period from 2000 to 2007.

Keeping in mind that the marginal effect of the female-owned establishment birth rate varies with the death rate, the birth-growth relationship is determined by the coefficient on the interaction term. If we were to again compare the effect across two counties, one with average entrepreneurial dynamism and one incrementally less dynamic, the latter would gain 3.9 percentage points in employment growth from a one unit increase in the women-owned establishment birth rate. A similar effect holds for the marginal effect of the death rate. Relatively large growth effects in less dynamic counties for both male and female entrepreneurial activity is the same pattern observed in the gender-blind results, suggesting again that there are diminishing returns to market information. Informational increments in the form of the revelations provided by openings and closures have substantially more impact in thin-market economies, as those successes and failures illuminate a relatively-unexplored market terrain.

Taken together, the results for the male and female specification also support the secondary gendered hypothesis. The marginal effect of a female-owned entrepreneurial project, be it a birth or death, is higher than that for an equivalent male-owned project, suggesting that women entrepreneurs may be sufficiently innovative to drive strong regional economic effects in the form of employment growth. Because relatively few women business owners have come before, women entrepreneurs are pioneering the market for those that follow. Not only are they illuminating market terrain through the informational mechanism of openings and closings, they are also creating the foundational nodes of a nascent network along gender lines. Incremental male-owned businesses are simply adding to an already well-developed network; each women-owned business more fundamentally helps build a parallel community system that can allow informational increments to be communicated and leveraged ever more effectively. The building of a women's entrepreneurial network is all the more important given that women—armed with their unique socio-economic perspective—are capable of identifying opportunities and market niches that may otherwise go unrecognized. Women can bring unique products, processes, services, and management styles to the market, the very definitions of innovation.

Considering one model which includes both male and female measures of entrepreneurial projects has two benefits. First, the specification is exhaustive in that it includes all estab-

lishments, but with the advantage of the gender decomposition. Second, in trying to identify the specific effects of either male or female entrepreneurship it is useful to control for the other gender. However, the combined specification presents a particular challenge in that instrumenting for six variables, let alone six gender-specific variables, is especially difficult. Male and female entrepreneurship result from distinct gendered behavioral processes (Conroy and Weiler, 2015), so finding a consistent set of instruments that are effective across two different populations adds a further degree of difficulty. In the IV specification, the first-stage results for the combined regression generally suggest significant but not strong, making it difficult to draw firm conclusions about the endogeneity of the gendered variables and employment growth. We therefore present the combined specification principally as a robustness check, leveraging the results of the prior gender-blind, male, and female specifications. Keeping in mind that the diagnostic results in all three previous IV specifications favored OLS estimation and that the present GMM distance test suggests that IVs aren't necessary, we again rely on the OLS results reported in Table 3.

The hypothesis that entrepreneurial projects have a positive effect on local employment growth holds for both female- and male-led projects. The effect of establishment births, both male and female-owned, is both positive and strongly significant. There is also a strong effect from male-owned establishment deaths as our theoretical framework predicts. The insignificant effect of female-owned establishment deaths suggests the importance of networks as an information transmission mechanism. Without strong networks through which to share useful business information, the positive information externality from an ineffective business attempt is lost. The results also underscore the diminishing-returns relationship between market information and employment growth as the coefficients on the interaction terms are negative. The resulting decrease in marginal effects is consistent with diminishing returns to entrepreneurial information even across gender. The benefits of an entrepreneurial project will be larger in a relatively less dynamic county as previous specifications.

In addition, the results provide further support of a gendered effect from entrepreneurial projects. Female-led establishment births have a larger positive effect on employment growth than do male-led projects, based on the contrasting coefficients on their respective birth rates. As there are fewer female-led establishment births and deaths both annually and cumulatively, each additional birth or death of a female-led establishment reveals more information about the market than an additional male-led establishment birth or death. Furthermore, the relative gradients of birth and death effects are much stronger in the female case, again emphasizing higher job growth returns to increments in women's entrepreneurship. This result underscores the importance of female entrepreneurial pioneers. These trailblazers not only shed light on particular markets, but also fill in the nodal structure for a network of women-owned businesses that can better relay and exploit their innovative advantages.

5 Conclusion and Policy Implications

The information generated by entrepreneurial projects has valuable externalities beyond the growth generated by such projects themselves. Leveraging the natural experiment contexts of regional economies to identify and evaluate information flows and their growth impact, we find that new business openings—even and especially their eventual closures—reveal information about the market, which in turn has identifiable and substantive effects on economic growth. This type of information reduces the uncertainty for incoming entrepreneurs who are developing their own ventures and evaluating their prospects for success. In markets with thinner information, entrepreneurs face more uncertainty, greater measured risk, likely higher financing and insurance hurdles, all of which may discourage them from pursuing their potentially-equally promising project. This underinvestment, a direct result of informational market failure, can lead to suboptimal outcomes, damaging both economic efficiency and equity.

Conceptually, our theoretical model hypothesizes a decreasing-returns relationship between information from entrepreneurial projects and economic growth. This diminishing-returns relationship between entrepreneurship and the economic payoff has specific implications in terms of both market scale and gender which we test empirically. In thin markets with relatively few new business openings and closures, even just a few additional entrepreneurial projects can expose broad swaths of relatively unknown market terrain and thus generate large incremental payoffs in terms of employment growth. In thick, dynamic markets, well-charted by the activity of past entrepreneurs, the marginal entrepreneurial projects adds relatively little new detail about the market, thus generating smaller gains in future employment growth. The empirical results and corresponding marginal effects support the hypothesized curvilinear relationship between entrepreneurial projects and employment growth. In thin markets, represented by counties with below average establishment birth and death rates, the marginal effect of an additional project (birth or death) on employment growth is larger than the marginal effect in thick markets represented by counties with above average establishment birth and death rates.

Intriguingly, we find that the gender aspect of entrepreneurship also reflects the same diminishing-returns relationship between market information from entrepreneurial projects and the gains in employment growth. With women representing a small share of business owners, both currently and historically, there is less market information available based on the female experience or about the market niches where women have been particularly innovative. Male entrepreneurs enter the market with a relative information advantage derived from the long-standing prevalence of men among business leaders. These men have fully-mature networks that regularly relay information flows in contrast to the more atomistic networks of women business owners (Aldrich et al., 1989).

Yet as a consequence of the relatively limited information based on and available to women entrepreneurs, their ventures are especially valuable for exposing lesser known aspects of the market compared with male-owned projects. This fresh information flow, alongside such ven-

tures' likely sizable foundational networking effects, subsequently lead to larger employment gains. Indeed the gender results of our analysis indicate that women-led projects, births and deaths, generate larger employment gains than male-led projects.

Thicker information flows through denser networks will, ceteris paribus, improve local entrepreneurial projects and enhance growth prospects for local establishments. In this sense, the paper's results provide additional evidence for encouraging entrepreneurial ecosystems in communities. Embracing broader entrepreneurial dynamism and appreciating the value of failures, rather than focusing exclusively on startups and success stories, is standard practice in mature clusters, such as the Silicon Valley (Saxenian, 1994), but takes encouragement in evolving entrepreneurial communities.

De-isolating particular networks such as those along gender lines may further reveal new market niches, business methods, and consumers' demands that add significant innovative value to products and services from emerging entrepreneurial markets. Altruism and cross-pollination across such traditional lines is again an accepted feature of more established ecosystems, but often requires explicit guidance in the earlier stages of network development. In that sense, fostering social infrastructure through informal and formal networking opportunities are likely to be complementary strategies for entrepreneurship and job creation. Such strategies are likely to be particularly effective in lagging regions which, as underscored by the paper's findings, are in the best position to benefit from informational and network increments.

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Table 6: Key Variable Comparison

Variable	Source	Definition	Mean	Std Dev	Min	Max
Births 1998						
Establishment Birth Rate	Census BITS	An establishment birth is counted when a business transitions from zero to positive employment. The number of births, as defined by the Census, is divided by total nonfarm employment (in thousands).	4.29	1.50	0.00	12.62
Establishment Birth Rate	NETS Database	An establishment birth is counted in the year an establishment is first active. The number of births, as defined based on NETS, is divided by total employment (in thousands) from the NETS database.	11.63	5.94	0.00	66.67
Women-owned Establishment Births	NETS Database	The establishment birth rate is calculated as above, but for the subset of establishments that are women-owned or managed. Women-owned or managed establishments are those that had a female CEO or a woman holding the controlling interest of the establishment in the most recent year of activity.	2.11	1.25	0.00	12.21
Male-owned Establishment Births	NETS Database	The establishment birth rate is calculated as above, but for the subset of establishments that are not women-owned or managed.	9.52	5.25	0.00	66.67
Deaths 1998						
Establishment Death Rate	Census BITS	An establishment death is counted when a business transitions from positive to zero employment. The number of deaths, as defined by the Census, is divided by total nonfarm employment (in thousands).	4.18	1.35	0.00	17.20
Establishment Death Rate	NETS Database	An establishment death is counted for establishment that active in previous year but inactive in the year observed. The number of deaths, as defined based on NETS, is divided by total employment (in thousands) from the NETS database.	7.15	2.82	0.00	66.67
Women-owned Establishment Deaths	NETS Database	The establishment death rate is calculated as above, but for the subset of establishments that are women-owned or managed. Women-owned or managed establishments are those that had a female CEO or a woman holding the controlling interest of the establishment in the most recent year of activity.	0.83	0.65	0.00	8.46
Male-owned Establishment Deaths	NETS Database	The establishment death rate is calculated as above, but for the subset of establishments that are not women-owned or managed.	6.32	2.55	0.00	66.67
Employment Growth '00-07						
Employment Growth	BEA-REIS	Growth in total nonfarm employment.	6.58	14.55	-35.32	168.51
Employment Growth	NETS Database	Growth in total employment.	7.83	16.73	-81.61	122.29

Number of Obs=3072 counties
BITS=Business Information Tracking System
BEA=Bureau of Economic Analysis
REIS=Business Information Tracking System

6 Instrumental Variable Analysis

Table 7: Employment Growth

		Obs=	3072		Obs=	3072		Obs=	3071		Obs	3071
		R^2 =	0.6405		R^2 =	0.6385		R^2 =	0.5493		R^2 =	0.5779
		FE=	State		FE=	State		FE=	State		FE=	State
		IV=	Yes		IV=	Yes		IV=	Yes		IV=	Yes
	Coef.	SE	P>|t|	Coef.	SE	P>|t|	Coef.	SE	P>|t|	Coef.	SE	P>|t|
C Birth Rate, 1998	0.8676	0.5391	0.108									
C Death Rate, 1998	1.2567	1.1714	0.283									
C B*D, 1998	-0.0238	0.1597	0.882									
C M Birth Rate, 1998				1.0802	0.5819	0.063				1.8549	1.1162	0.097
C M Death Rate, 1998				1.3126	1.2258	0.284				1.5840	1.4427	0.272
C M B*D, 1998				-0.0192	0.2448	0.937				0.0947	0.4807	0.844
C F Birth Rate, 1998							12.9268	3.7934	0.001	0.6205	6.5675	0.925
C F Death Rate, 1998							-9.8821	11.7467	0.400	-16.3956	14.7175	0.265
C F B*D, 1998							0.1462	4.2563	0.973	-1.6511	8.3461	0.843
Demand Shock, 2000-07	0.1792	0.0894	0.045	0.1901	0.0887	0.032	0.1862	0.0808	0.021	0.2604	0.1014	0.010
Emp Growth, 1990-2000	0.1546	0.0353	0.000	0.1548	0.0349	0.000	0.1062	0.0364	0.004	0.1293	0.0532	0.015
Log Employment, 2000	0.3454	0.6163	0.575	0.2493	0.6337	0.694	1.3409	0.4843	0.006	-0.1117	1.3590	0.934
Log Income, 2000	-16.2492	3.1024	0.000	-16.6465	3.1175	0.000	-13.9039	3.5445	0.000	-17.3255	4.1350	0.000
Density, 2000	0.0658	0.0382	0.085	0.0617	0.0392	0.115	0.0623	0.0391	0.111	0.0340	0.0520	0.513
BA Share, 2000	-0.2909	0.1221	0.017	-0.2963	0.1248	0.018	-0.1898	0.1276	0.137	-0.2647	0.1736	0.127
HC Share, 2000	0.6353	0.2169	0.003	0.6480	0.2222	0.004	0.4218	0.2220	0.057	0.5851	0.2854	0.040
Arts Share, 2000	-0.3224	0.8821	0.715	-0.2383	0.8894	0.789	-0.9625	0.8348	0.249	0.1687	1.1369	0.882
Pop Growth 1950-1960	-1.4072	1.0188	0.167	-1.4204	1.0019	0.156	0.1744	0.8393	0.835	-1.0085	1.0628	0.343
Median Age, 2000	-0.3716	0.1161	0.001	-0.3465	0.1122	0.002	-0.3494	0.1583	0.027	-0.1376	0.2028	0.498
Amenity Score	-0.0869	0.2275	0.702	-0.0793	0.2388	0.740	-0.2347	0.2402	0.328	-0.1694	0.2890	0.558
Distance to MSA	-0.2284	0.6873	0.74	-0.2291	0.6869	0.739	0.0326	0.7186	0.964	-0.1620	0.6942	0.816
Marg dist MSA > 250k	-0.2381	0.3206	0.458	-0.2832	0.3175	0.372	0.5686	0.4726	0.229	-0.1842	0.5564	0.741
Marg dist MSA > 500k	0.2929	0.2409	0.224	0.3225	0.2434	0.185	0.2702	0.2823	0.339	0.5129	0.3255	0.115
Marg dist MSA > 1M	0.4753	0.2992	0.112	0.4581	0.3001	0.127	0.8403	0.3565	0.018	0.5076	0.4023	0.207
cons	152.4612	40.50618	0.000	158.3917	41.4652	0.000	116.2382	41.1984	0.005	164.6151	55.3652	0.003
	test stat	p-val		test stat	p-val		test stat	p-val		test stat	p-val	
Test Weak ID: Births	43.08	0.000										
Test Weak ID: Deaths	24.61	0.000										
Test Weak ID: B*D	21.46	0.000										
Test Weak ID: M Births				48.07	0.000					9.31	0.0000	
Test Weak ID: M Deaths				22.20	0.000					9.89	0.0000	
Test Weak ID: M B*D				16.74	0.000					4.54	0.0000	
Test Weak ID: F Births							11.73	0.000		7.99	0.0000	
Test Weak ID: F Deaths							10.27	0.000		6.97	0.0001	
Test Weak ID: F B*D							15.56	0.000		4.53	0.0036	
Cragg Donald	20.92			16.159			5.982			1.86		
Hansen J	0.024	0.877		0.058	0.8103		2.1220	0.145		0.027	0.9864	
Endog	3.21	0.360		1.807	0.6134		5.5180	0.1376		5.71	0.4561	