A Theory of University Startups and Local Employment

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University Invention and Local Development

- **Bayh-Dole Act of 1980 - university technology transfer officers (TTOs) are responsible for making good-faith efforts to commercialize university inventions; universities also required to give faculty inventors some revenue from license agreements.**
- **Most state universities have mission statements that require they assist in state/local economic development**
- **Belenzon and Schankerman (2009) report that, in a survey of 86 U.S. universities, 77% stated that the promotion of local and regional economic development was either very important or moderately important as an objective of technology licensing.**
- **Some universities seem to view research parks and incubators as crucial to this mission: include statements to the effect that their goal is to facilitate the commercialization of university research via startup firms, and to support the attraction and growth of high-technology businesses in the area.**

Related Literature

Theoretical literature on university licensing predominantly focuses on the behavior of faculty and TTOs in licensing those inventions

- **Jensen and Thursby (2001)**
- **Jensen, Thursby, and Thursby (2003)**
- **Hoppe and Ozdenoren (2004)**
- **Chukumba and Jensen (2005)**
- **Macho-Stadler, Perez-Castrillo, and Veugelers (2007, 2009)**
- **Lach and Shankerman (2008)**
- **Decheneaux, Thursby, and Thursby (2009)**
- **Belenzon and Schankerman (2009)**
- **Showalter (2010)**

Only Belenzon and Schankerman consider local objectives of any type in the licensing process, but their interest is focused on how faculty-inventor compensation influences the TTO's decision of how much effort to focus on licensing in the national market viz a viz the local market. Their analysis ignores the licensees and the nature of the licensing contracts.

Model I: Timeline

- **Three players: TTO (agent for university), inventor, and firm**
- **Given disclosure, TTO makes an assessment and, if promising enough, searches for a firm willing to acquire a license for this new technology. Typical contract includes up-front, lump-sum fee m and royalty rate r**
- **University inventions are typically embryonic: commercial potential is uncertain, likelihood of success is small, and additional development effort by the firm with assistance from the inventor is usually required for any chance of success.**
- **Thus, if a firm acquires a license, there follows a development subgame in which firm and the inventor devote effort to attempt to improve the commercial potential of the potential invention. The outcome of this game is a probability of success. Given this, firm may attempt to commercialize, after which it learns whether the invention is a success or not.**
- **If success, production occurs and royalties paid to university.**

Model II: Net Profit from Success

Firm profit from a success is

$\Pi(K,L) = [P(f(K,L)) - r]f(K,L) - \rho K - \omega L$.

where

K = capital, L = labor, Q = f(K,L) is production function

P(Q) is inverse demand function,

ρ = rental rate of capital, ω = wage

First order necessary conditions

- **$\partial\Pi(K,L)/\partial K = [MR(Q) - r]MP_K(K,L) - \rho = 0$**
- **$\partial\Pi(K,L)/\partial L = [MR(Q) - r]MP_L(K,L) - \omega = 0$**

These define input demand functions $K^*(r,\rho,\omega)$ and $L^*(r,\rho,\omega)$.

Prop. 1: Optimal employment is decreasing in the royalty rate (as long as labor is not an inferior input)

Model III: Development Subgame

Let p(e,E) be the probability of commercial success given inventor effort e and firm effort E in development

Firm expected profit from effort E is

$$\Phi_F(e,E) = p(e,E)\{[P(Q^*) - r]Q^* - \rho K^* - \omega L^*\} - m - D_F(E)$$

Inventor's preferences given by net utility $U_I(Y) - D_I(e)$,
where $U_I(Y)$ is utility of income Y and $D_I(e)$ is disutility of effort

Inventor expected utility from effort e is

$$\Phi_I(e,E) = p(e,E)U_I(\alpha[rQ^*+m]) + [1 - p(e,E)]U_I(\alpha m) - D_I(e)$$

where α is inventor share of license revenue.

Model III: Development Subgame (cont)

Assume $e = 0$ or e_H and $E = 0$ or E_H

Prop. 2: Development of the invention disclosure occurs in equilibrium for contracts (r,m) such that

$$p(e_H,E_H)\{[P(Q^*) - r]Q^* - \rho K^* - \omega L^*\} \geq D_F(E_H)$$

and

$$p(e_H,E_H)[U_I(\alpha[rQ^*+m]) - U_I(\alpha m)] \geq D_I(e_H).$$

It is the unique equilibrium if these inequalities hold strictly.

Otherwise, no development is the unique equilibrium.

Prop. 3: Development does not occur in equilibrium unless the license contract involves a positive royalty rate.

Model IV: TTO Licensing Decision

TTO's preferences given by utility $U_T(Y,L)$, so expected utility from contract (r,m) is

$$\Phi_T(r,m) = p(e_H,E_H)U_T((1-\alpha)(m+rQ^*),L^*) + [1-p(e_H,E_H)]U_T((1-\alpha)m,0)$$

Prop. 4: If the TTO executes a license contract (r*,m*) such that development occurs in equilibrium, and if labor is not an inferior input, then the optimal royalty rate r* is less than the one which would be chosen if the TTO had no preference for generating employment.

$$\partial\Phi_T(r,m)/\partial r = p(e_H,E_H)\,[(\partial U_T(Y_s,L^*)/\partial Y)(1-\alpha)[Q^* + r(\partial Q^*/\partial r)] + (\partial U_T(Y_s,L^*)/\partial L)(\partial L^*/\partial r)]$$

Empirical Confirmation?

Data

- **Association of University Technology Managers annual surveys provide data from 1991 to 2008:**

  515 universities

  60 private

  56 land grant

  128 with a medical school

- **National Research Council data (1994) on faculty quality in engineering and life sciences for universities with graduate programs**

- **Venture capital funding from the National Venture Capital Association Yearbook (2008)**

Estimation

Estimate relationships between measures of startups and natural explanatory variables. Measures we use are

- **number of licenses executed to startup firms LIC_STRT**
- **number of startup firms located in home state STRT_HS**

Use negative binomial regression because these are count data.

For each we use specification of the form

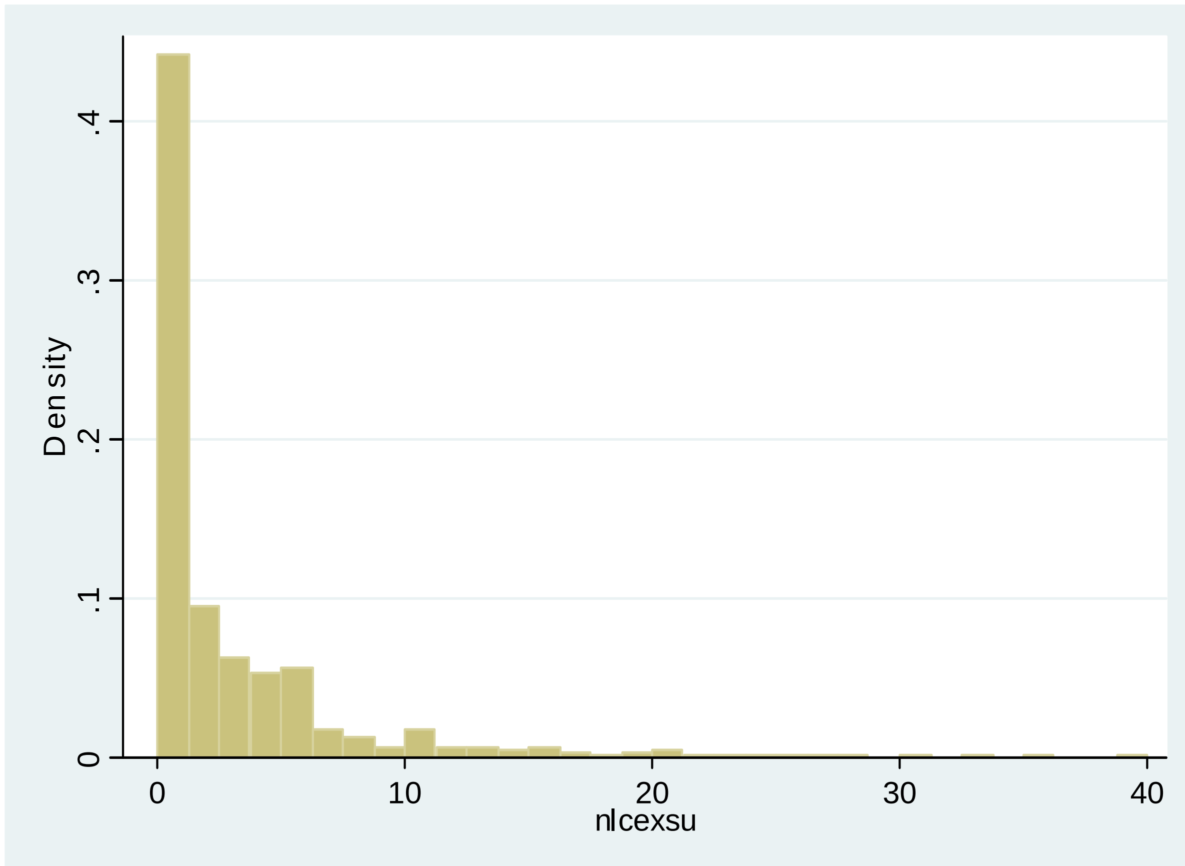
$$Y_{it} = \alpha_{it} + \beta_1 X_{1i} + \beta_2 X_{2it} + \varepsilon_{it}$$

where Y_{it} is the startup measure in university i in year t,

X_{1i} is a vector of time-invariant variables,

X_{2it} is a vector of time-varying variables, and

ε_{it} is an error term.



Density
0
.1
.2
.3
.4
0
10
20
30
40
nlcexsu

Table 1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LIC_STRT	2563	3.072	4.860	0	60
STRT_HS	2333	1.876	2.993	0	49
LNROYALTY	2275	13.071	2.505	4.443	20.530
AVELNROYALTY	1636	1.602	2.057	0.033	12.975
NASDAQ	4067	10.293	33.902	-68.18	84.3
LNVENTCAP	5784	18.634	3.920	0.001	24.474
VC_5YR_RR	3848	16.447	15.722	-6.5	48.2
IR_10	3848	5.461	1.102	4.01	7.86
LANDGRANT	2677	0.306	0.461	0	1
PRIVATE	2979	0.291	0.454	0	1
SCISIZE	2450	240.037	322.544	9	3225
SCIQUALITY	2450	2.891	0.779	1.036	4.746
ENGSIZE	1705	100.137	86.126	7	423
ENGQUALITY	1705	2.761	0.829	1.008	4.631
TTOSIZE	3177	3.984	5.674	0	95
TTOAGE	3337	13.601	11.221	0	83
LNFEDFND	3243	17.789	1.346	9.867	21.616
LNINDFND	3176	15.689	1.411	4.663	19.709
INV_DIS	3340	71.707	100.471	0	1497

Table 2: Negative Binomial Regressions for Number of Licenses Executed to Startup Firms

LIC_STRT		LIC_STRT	
LNROYALTY	0.054***	AVELNROYALTY	-0.112***
	(0.017)		(0.031)
NASDAQ	-0.002**	NASDAQ	0.000
	(0.001)		(0.002)
LNVENTCAP	0.023*	LNVENTCAP	0.014
	(0.013)		(0.015)
VC_5YR_RR	0.007**	VC_5YR_RR	-0.011***
	(0.003)		(0.004)
IR_10	-0.326***	IR_10	0.153
	(0.095)		(0.107)
LANDGRANT	-0.106*	LANDGRANT	-0.152**
	(0.064)		(0.077)
PRIVATE	-0.304***	PRIVATE	-0.351***
	(0.078)		(0.094)
SCISIZE	-1.86E-04	SCISIZE	-4.46E-04**
	(1.60E-04)		(2.16E-04)
SCIQUALITY	0.011	SCIQUALITY	0.088
	(0.096)		(0.112)
ENGSIZE	-0.001	ENGSIZE	0.000
	(0.001)		(0.001)
ENGQUALITY	0.367***	ENGQUALITY	0.347***
	(0.089)		(0.104)
TTOSIZE	-0.030***	TTOSIZE	-0.014
	(0.009)		(0.011)
TTOAGE	0.004	TTOAGE	-0.002
	(0.002)		(0.003)
LNFEDFND	0.199***	LNFEDFND	0.109*
	(0.055)		(0.064)
LNINDFND	0.067**	LNINDFND	0.056
	(0.034)		(0.037)
INV_DIS	0.003***	INV_DIS	0.003***
	(0.001)		(0.001)
N	925		619
PSEUDO R^2	0.13		0.12

Table 3: Negative Binomial Regressions for the Number of Startups Located in the Home State

STRT_HS		STRT_HS	
LNROYALTY	0.015	AVELNROYALTY	-0.027
	(0.017)		(0.031)
NASDAQ	-0.003**	NASDAQ	-0.002
	(0.001)		(0.002)
LNVENTCAP	0.036**	LNVENTCAP	0.020
	(0.015)		(0.016)
VC_5YR_RR	0.005	VC_5YR_RR	-0.006*
	(0.004)		(0.003)
IR_10	-0.220**	IR_10	0.119
	(0.107)		(0.101)
LANDGRANT	-0.174***	LANDGRANT	-0.215***
	(0.065)		(0.074)
PRIVATE	-0.342***	PRIVATE	-0.300***
	(0.081)		(0.092)
SCISIZE	-4.16E-04***	SCISIZE	-5.16E-04***
	(1.24E-04)		(1.51E-04)
SCIQUALITY	0.042	SCIQUALITY	0.017
	(0.095)		(0.104)
ENGSIZE	0.001	ENGSIZE	0.001**
	(0.001)		(0.001)
ENGQUALITY	0.232***	ENGQUALITY	0.237
	(0.090)		(0.101)
TTOSIZE	-0.011	TTOSIZE	-0.006
	(0.008)		(0.008)
TTOAGE	0.004*	TTOAGE	0.002
	(0.002)		(0.003)
LNFEDFND	0.145**	LNFEDFND	0.148**
	(0.058)		(0.066)
LNINDFND	0.070**	LNINDFND	0.046
	(0.035)		(0.037)
INV_DIS	0.003***	INV_DIS	0.003***
	(0.000)		(0.000)
N	844		609
PSEUDO R^2	0.15		0.15

Conclusions

- **Use of royalties in university licensing is inconsistent with local employment as an objective of university technology transfer**
- **When royalties are used, they are lower the greater the weight placed on employment as an objective**
- **Preliminary empirical work shows that average royalties (royalty payments per license) are negatively correlated with the total number of startups licensed, but not the number of startups located in the home state**
- **Future research should consider the use of equity instead of royalties and the financing of research/innovation parks**