Faculty Disclosures, University Invention and Entrepreneurship

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The purpose of this paper:

I examine the factors that contribute to faculty disclosing new inventions to technology transfer officers, (TTOs).

I determine the conditions under which this occurs. I empirically examine the affects of venture capital spending and financial market conditions on faculty disclosures.

Literature Review

- The theoretical literature has predominantly focused on the effects of the Bayh-Dole Act, and the behavior of inventors and technology transfer officers (TTOs):
- Jensen, Thursby, and Thursby (2003) find that higher quality faculty disclose inventions at earlier stages of development .
- Thursby and Thursby (2004) show that the age of the inventor seems to affect faculty disclosures.
- Lach and Schankerman (2002) examine royalties and the value each disclosure adds to licensing income. Universities with higher royalty shares for their faculty invent less and their inventions have higher average value in terms of royalty income per disclosure.
- Shane (2002) Inventor-founded start-ups have cost advantages due to the inventor's superior knowledge of the technology, which can limit transactional and informational problems. Faculty that disclose are needed for start-ups .....later.
- Di Gregoriao and Shane (2003), find evidence that inventor quality has a positive impact on start-up activity using the Gourman Report. Does quality matter?
- Thursby and Thursby and Mukherjee (2005) argue that faculty incentives to disclose are not due to financial motives but are caused by an increase in faculty desires to expend effort in licensing activities.

Chukumba (2004)

- I argue that Bayh-Dole legislation and increased profit sharing use by universities (Penn State 40 inventor/40 university/ 20 administrative) and increased venture capital spending, and TTO willingness to use cashed-in-equity and start-ups contribute this increased desire to expend effort.
- Previous efforts have not focused/connected financial characteristics such as the availability of venture capital as it relates to faculty willingness to disclose.
- I use specific inventor quality measures as opposed to general school rankings. I construct a measure for each university by forming a weighted average of the engineering and science department quality scores, where the weights are faculty size.
- The relationship between venture capital and faculty disclosures is clarified. Financial Variables add value to current literature.
- Financial conditions/financial incentives matter.
- 1. When venture capital spending occurs → financial incentives for inventors rise → more disclosures.
- 2. When financial conditions are better such as increasing returns to capital → financial incentives for inventors rise → more disclosures.

Data

- The National Research Council 1993 (NRC 1995) Survey of Ph.D. Granting Institutions
- The Association of University Technology Managers (AUTM) FY's 1993-2002

-Dependent Variable

1.Faculty Disclosures

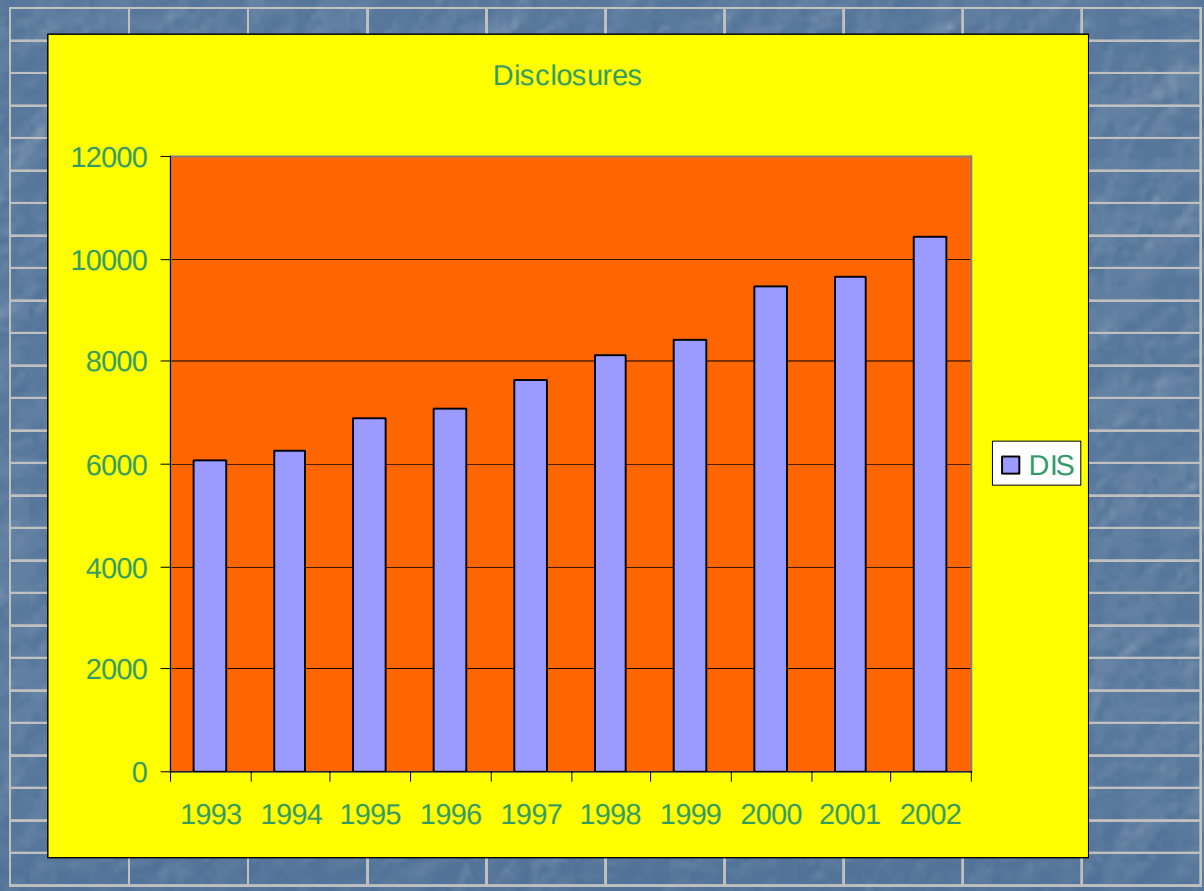
Negative Binomial Estimation.

Unbalanced Panel of 110 Universities

The National Venture Capital Association Yearbook

Faculty disclosures for 110 U. S. universities from 1993 to 2002.

- 1993 = 6075
- 2002 = 10,419



Variables used to Predict Disclosures

Dependent Variable = Invention Disclosures Received for all universities per year.
Inventor Characteristics
NRC overall Quality Engineering Ranking weighted by department
NRC overall Quality Sciences Ranking weighted by department
NRC overall Quality Ranking weighted by department
University is private (yes = 1)
TTO Characteristics
Licensing FTE's in Technology Transfer Offices
TTO Age - Program Year Technology Transfer Office Began
Start-up Companies Formed
Log of Gross License Income Received
License Income Received:Cashed-In Equity
Invention Characteristics
University has Medical School (yes = 1)
Industrial/Federal Research Expenditure
Venture Capital Conditions
Log of Venture Capital Expenditure
Log of Venture Capital Expenditure per State
University is located in a High Venture Capital Expenditure State (yes = 1)
Financial Market Conditions
Returns to the S & P 500 index
Returns to the Nasdaq index

Descriptive Statistics:

Variable	Obs.	Mean	Std. Dev.	Min	Max
Invention Disclosures Received	956	83.24163	100.1542	0	973
Inventor Characteristics					
NRC overall Quality Engineering Ranking weighted by department	830	2.867632	.8175862	1.24	4.631456
NRC overall Quality Sciences Ranking weighted by department	1080	2.974425	.8326953	.7170588	4.746132
NRC overall Quality Ranking weighted by department	1100	2.923386	.798214	1.203704	4.697401
University is private (yes = 1)	1100	.3554545	.4788685	0	1
TTO Characteristics					
Licensing FTE's in Technology Transfer Offices	951	3.259474	5.026659	0	62
TTO Age - Program Year Technology Transfer Office Began	971	14.19773	12.27503	0	77
Start-up Companies Formed	951	3.203996	5.624048	0	64
Log of Gross License Income Received	950	13.88279	1.977126	6.60665	19.40562
License Income Received:Cashed-In Equity	625	2.860903	5.477156	0	18.02734
Invention Characteristics					
University has Medical School (yes = 1)	1100	.5927273	.4915499	0	1
Industrial/Federal Research Expenditure	951	.1765053	.1825192	0	1.610801
Venture Capital Conditions					
Log of Venture Capital Expenditure	1100	23.56057	1.035862	22.02037	25.38532
Log of Venture Capital Expenditure per State	1100	18.87763	2.964445	0	24.4911
University is located in a High Venture Capital Expenditure State (yes = 1)	1100	.2736364	.4460273	0	1
Financial Market Conditions					
Returns to the S & P 500 index	1100	13.06	7.591099	-1.9	26.2
Returns to the Nasdaq index	1100	17.16	10.67211	-3.2	40.2

Expected Signs:

- INVENTOR CHARACTERISTICS

  Engineering Quality (+), Science Quality (+), Quality (+), University is Private(?)

- TTO CHARACTERISTICS

  TTO Size - FTE's(+), TTO Age – Program Year (+), Start- up Companies Formed (+), Gross Licensing Income (+), Cashed-in-Equity(+),

- INVENTION CHARACTERISTICS

  Medical School(+), Ind/Fed Ratio(?)

- VENTURE CAPITAL CONDITIONS

  Log of Venture Capital Expenditure US (+), Log of Venture Capital State (+), University is located in High Venture Capital State (+)

- FINANCIAL MARKET CONDITIONS

  S & P 500 Level (+), NASDAQ Index Level (+)

Findings Tables 1.3 and 1.4

-The estimated coefficient for engineering faculty quality is positive and significant

-Moving from a 3 to a 4 in engineering faculty quality results in a .654 change in disclosures.

-The estimated coefficient for life sciences faculty quality is negative and not significant

-Private Universities receive .34 less disclosures.

-Universities with medical schools receive .48 more disclosures.

-The estimated coefficients for TTO size and TTO AGE are positive and significant.

-A 10 year increase in age results in 17 percent increase in disclosures. “TTOs Learning by doing”

-Adding an additional full time technology transfer officer results in a .011 change in disclosures.

-The estimated coefficient for the log of venture capital is positive and significant.

-Industrial to federal research support ratio helps to predict disclosures. Jensen, Thursby and Thursby (2003) found that the ind/fed ratio did not help to predict the stage of development at which inventions are disclosed proof, prototype, etc.

-Each new dollar of venture capital funding results in a .08 change in disclosures.

-Faculty located in high venture capital states are 18 % more likely to disclose.

Conclusions

- Attract venture capital to your state and university. Venture Capital spending matters. Faculty in high venture capital states invent more.
- Choose the best quality engineering faculty that can be obtained. If constraints in budgeting exist. Life sciences quality is less important than engineering quality. (for generating disclosures – these may not be commercialized)
- Affiliate institution with a medical school or develop links/ties to medical institutions for training faculty and conducting faculty research.
- TTO cumulative licensing experience with start-ups induces faculty to invent.

Dependent Variable = Disclosures				
	Model 1	Model 2	Model 3	Model 4
Inventor Characteristics				
ENGQUAL	0.65453	0.64592		
	[0.10656]**	[0.11654]**		
SCIQUAL	-0.07428	0.02027		
	[0.11510]	[0.12571]		
QUAL			0.53822	0.62812
			[0.06302]**	[0.07141]**
PRIVATE	-0.34033	-0.43102	-0.33084	-0.45161
	[0.10168]**	[0.11818]**	[0.09758]**	[0.11433]**
Invention Characteristics				
INDFED	0.09255	0.06448	-0.02471	-0.05532
	[0.10567]	[0.11798]	[0.10179]	[0.12152]
MED	0.48218	0.52597	0.14707	0.14319
	[0.08903]**	[0.10069]**	[0.08436]	[0.09340]
TTO Characteristics				
TTOAGE	0.01706	0.01488	0.02052	0.01725
	[0.00311]**	[0.00352]**	[0.00322]**	[0.00372]**
TTOSIZE	0.01124	0.00544	0.01288	0.00581
	[0.00240]**	[0.00274]*	[0.00249]**	[0.00300]
STP	0.00278	0.00449	0.00285	0.00548
	[0.00156]	[0.00354]	[0.00144]*	[0.00262]*
ACT		0.00009		0.00014
		[0.00011]		[0.00012]
LNCAINE		-0.00252		-0.00038
		[0.00230]		[0.00239]
LNGROSS	0.05846	0.04636	0.07899	0.07329
	[0.01499]**	[0.01875]*	[0.01339]**	[0.01747]**
Venture Capital Conditions				
LNVC	0.08058	0.03835	0.0479	0.01023
	[0.01530]**	[0.02257]	[0.01483]**	[0.02082]
LNVCSTAT	0.00327	0.03639	0.00131	0.01781
	[0.00682]	[0.01630]*	[0.00652]	[0.01285]
HIGHVCST	0.18019	0.11009	0.17418	0.16045
	[0.11395]	[0.13362]	[0.10469]	[0.12178]
Financial Market Conditions				
RLAVESP	-0.00264	-0.0099	-0.00061	-0.00637
	[0.00388]	[0.00434]*	[0.00371]	[0.00439]
RLAVENAS	-0.00172	0.00225	-0.00135	0.00181
	[0.00261]	[0.00291]	[0.00251]	[0.00294]
Constant	-2.01293	-1.33311	-1.46645	-0.81012
	[0.37111]**	[0.48406]**	[0.35726]**	[0.47122]
Observations	655	433	845	571
Number of schlcodes	77	76	103	102
Log Likelihood	-2902.91712	-1920.0813	-3723.2464	-2544.021
Standard errors in brackets				
* significant at 5%; ** significant at 1%				

Dependent Variable = Disclosures				
	Model 1	Model 2	Model 3	Model 4
Inventor Characteristics				
MEDENGQUAL	0.83506	0.94221		
	[0.12737]**	[0.14723]**		
HIGHENGQUAL	0.47857	0.43308		
	[0.21526]*	[0.26054]		
MEDQUAL			0.17346	0.26656
			[0.13107]	[0.15504]
HIGHQUAL			0.30738	0.11039
			[0.22074]	[0.25609]
PRIVATE	-0.20644	-0.30208	-0.21044	-0.30003
	[0.10429]*	[0.12571]*	[0.11386]	[0.13742]*
Invention Characteristics	-0.11115	-0.20822	-0.12722	-0.22677
INDFED	[0.10137]	[0.12246]	[0.10188]	[0.12488]
	0.25996	0.27953	0.24394	0.23223
MED	[0.09306]**	[0.10628]**	[0.10030]*	[0.11615]*
	0.0258	0.02354	0.02625	0.02433
TTO Characteristics				
TTOAGE	[0.00353]**	[0.00432]**	[0.00381]**	[0.00465]**
	0.01103	0.00524	0.01373	0.00692
TTOSIZE	[0.00241]**	[0.00273]	[0.00257]**	[0.00305]*
	0.00342	0.00465	0.00317	0.00526
STP	[0.00150]*	[0.00285]	[0.00153]*	[0.00270]
		0.00015		0.00017
ACT		[0.00011]		[0.00012]
		-0.00112		-0.00055
LNCAINE		[0.00234]		[0.00251]
	0.09603	0.09727	0.09629	0.10155
LNGROSS	[0.01335]**	[0.01777]**	[0.01370]**	[0.01827]**
Venture Capital Conditions				
LNVC	0.02866	-0.00658	0.02246	-0.01485
	[0.01468]	[0.02107]	[0.01542]	[0.02141]
LNVCSTAT	0.00356	0.01952	0.00315	0.0187
	[0.00630]	[0.01298]	[0.00656]	[0.01295]
HIGHVCST	0.29942	0.36881	0.34538	0.45655
	[0.11378]**	[0.14040]**	[0.11871]**	[0.14819]**
Financial Market Conditions				
RLAVESP	-0.00172	-0.00673	-0.00169	-0.00578
	[0.00370]	[0.00439]	[0.00378]	[0.00453]
RLAVENAS	0.0006	0.00362	0.00093	0.00363
	[0.00249]	[0.00291]	[0.00255]	[0.00300]
Constant	-0.01972	0.68883	0.20377	0.89499
	[0.30834]	[0.44369]	[0.32528]	[0.45678]
Observations	845	571	845	571
Number of schlcode	103	102	103	102
Log Likelihood	-3732.874	-2556.2932	-3750.6926	-2573.2433
Standard errors in brackets				
* significant at 5%; ** significant at 1%				

Dependent Variable = Disclosures				
	Model 1	Model 2	Model 3	Model 4
Inventor Characteristics				
ENGQUAL	30.07046	20.8025		
	[4.22164]**	[4.30456]**		
SCIQUAL	-3.83606	-0.5661		
	[4.53577]	[4.52184]		
QUAL			19.64437	12.26733
			[2.67912]**	[3.16343]**
PRIVATE	-11.68197	-6.82615	-8.76804	-2.88076
	[4.21180]**	[4.15477]	[3.70820]*	[4.34382]
Invention Characteristics				
INDFED	21.86114	16.56164	16.00678	9.95701
	[9.47235]*	[8.78301]	[8.71881]	[9.54190]
MED	13.43112	10.6878	0.19037	-0.71326
	[3.69092]**	[3.65291]**	[3.20055]	[3.66220]
TTO Characteristics				
TTOAGE	0.79649	0.37748	0.79722	0.23435
	[0.12766]**	[0.13590]**	[0.12497]**	[0.15332]
TTOSIZE	11.95429	10.04677	12.21579	9.69625
	[0.34000]**	[0.37999]**	[0.35026]**	[0.46675]**
STP	1.84797	8.86979	2.1607	8.97851
	[0.32150]**	[0.55165]**	[0.29729]**	[0.50045]**
ACT		0.05778		0.09139
		[0.01223]**		[0.01361]**
LNCAINE		0.31851		0.47304
		[0.33190]		[0.33929]
LNGROSS	2.9216	1.19793	2.97613	1.09499
	[1.25173]*	[1.20823]	[1.02683]**	[1.18490]
Venture Capital Conditions				
LNVC	1.55337	-2.03233	-0.0972	-4.09114
	[1.99701]	[2.37566]	[1.82363]	[2.47336]
LNVCSTAT	0.39485	0.79891	0.87329	0.16059
	[0.65477]	[0.89781]	[0.57864]	[0.73687]
HIGHVCST	3.8857	-2.0748	-5.49025	-4.01221
	[4.88572]	[4.99848]	[4.18188]	[4.85043]
Financial Market Conditions				
RLAVESP	-0.99666	-0.18944	-0.6096	0.1478
	[0.65267]	[0.64680]	[0.58974]	[0.68604]
RLAVENAS	0.74744	0.21023	0.56269	0.11442
	[0.43814]	[0.44302]	[0.39502]	[0.46763]
Constant	-142.27726	-31.23679	-94.85483	50.51273
	[44.05036]**	[55.51837]	[40.10522]*	[57.92729]
Observations	655	433	845	571
Pseudo R2	0.5455	0.6082	0.489	0.5472
Standard errors in brackets				
* significant at 5%; ** significant at 1%				

Dependent Variable = Disclosures				
	Model 1	Model 2	Model 3	Model 4
Inventor Characteristics				
ENGQUAL	36.35405	30.25621		
	[5.57843]**	[5.73954]**		
SCIQUAL	-2.74451	-4.46761		
	[6.30712]	[5.78225]		
QUAL			25.16486	18.09094
			[3.36577]**	[4.17312]**
PRIVATE	-5.08068	-6.38591	-9.95705	-3.26612
	[5.13627]	[5.30764]	[4.12385]*	[5.41133]
Invention Characteristics				
INDFED	34.21454	20.36009	16.55169	12.41791
	[10.49484]**	[9.36753]*	[9.42586]	[9.95045]
MED	11.25194	15.318	-4.89338	-0.33418
	[4.68538]*	[4.53016]**	[3.85845]	[4.69682]
TTO Characteristics				
TTOAGE	1.03307	0.36819	0.91346	0.2728
	[0.15409]**	[0.18544]*	[0.14791]**	[0.20817]
TTOSIZE	13.10268	10.20687	13.40917	10.05145
	[0.50745]**	[0.48225]**	[0.45406]**	[0.54699]**
STP	5.73905	9.3475	6.02615	9.46243
	[0.34907]**	[0.66035]**	[0.29012]**	[0.52776]**
ACT		0.09079		0.11604
		[0.01287]**		[0.01414]**
LNCAINE		0.28706		0.824
		[0.42212]		[0.43839]
LNGROSS	2.43408	2.00374	2.95309	2.10217
	[1.58946]	[1.56577]	[1.20169]*	[1.51374]
Venture Capital Conditions				
LNVC	1.94232	-0.79316	0.16092	-4.43107
	[2.59802]	[2.99605]	[2.13955]	[3.21594]
LNVCSTAT	0.32195	0.95758	0.79829	0.55588
	[1.02207]	[1.25131]	[0.80271]	[1.06297]
HIGHVCST	2.09371	-3.79754	-0.13825	-8.6435
	[6.24634]	[6.42924]	[4.79273]	[6.13546]
Financial Market Conditions				
RLAVESP	-0.99993	-0.30288	-0.26009	-0.14534
	[0.89217]	[0.82607]	[0.72717]	[0.88199]
RLAVENAS	0.7543	0.31413	0.51926	0.352
	[0.59153]	[0.56569]	[0.48084]	[0.59805]
Constant	-159.22068	-79.79141	-107.64159	34.47235
	[57.49694]**	[68.65882]	[47.03537]*	[73.54115]
Observations	655	433	845	571
Pseudo R2	0.6043	0.6758	0.5639	0.6366
Standard errors in brackets				
* significant at 5%; ** significant at 1%				

Dependent Variable = Disclosures				
	Model 1	Model 2	Model 3	Model 4
Inventor Characteristics				
ENGQUAL	34.01184	25.6525		
	[9.09987]**	[9.36465]**		
SCIQUAL	2.16208	-0.58867		
	[11.19256]	[9.35674]		
QUAL			27.67873	19.77826
			[7.14519]**	[6.78237]**
PRIVATE	-4.13219	-3.09668	-5.20545	-4.63412
	[11.75297]	[11.23419]	[8.48832]	[8.61892]
Invention Characteristics				
INDFED	27.03952	13.52688	22.07254	21.66842
	[10.92851]*	[10.80063]	[11.22783]	[11.08331]
MED	1.94799	5.33579	-12.33035	-7.27626
	[10.16518]	[8.22488]	[9.50165]	[8.63118]
TTO Characteristics				
TTOAGE	0.99636	0.67021	1.06942	0.71541
	[0.37495]**	[0.38454]	[0.42730]*	[0.44454]
TTOSIZE	12.19666	10.53943	12.58999	10.65968
	[1.01044]**	[0.67424]**	[1.20279]**	[0.99998]**
STP	2.51169	9.05736	2.47632	6.09132
	[0.68323]**	[1.31772]**	[0.71690]**	[2.88101]*
ACT		0.03217		0.0762
		[0.04461]		[0.04914]
LNCAINE		0.13539		0.3608
		[0.59104]		[0.48305]
LNGROSS	3.08292	1.85787	3.5227	1.52814
	[2.04578]	[2.12293]	[1.63356]*	[1.71576]
Venture Capital Conditions				
LNVC	2.38828	-4.73945	-0.45082	-5.32819
	[2.44143]	[2.89556]	[2.26097]	[2.62444]*
LNVCSTAT	1.81491	2.88789	1.51971	1.73034
	[1.20062]	[1.77496]	[0.90293]	[1.38618]
HIGHVCST	7.37058	-4.83722	-0.01987	-5.8643
	[14.52845]	[15.06724]	[11.65099]	[11.23784]
Financial Market Conditions				
RLAVESP	-0.28718	0.50459	-0.04355	0.80437
	[0.37973]	[0.53395]	[0.36269]	[0.51157]
RLAVENAS	0.23069	0.00792	0.25185	-0.10496
	[0.26936]	[0.37638]	[0.22266]	[0.32187]
Constant	-216.42655	-33.78358	-127.38983	20.44113
	[54.74403]**	[57.89738]	[51.83812]*	[59.43675]
Observations	655	433	845	571
R-squared	0.83	0.88	0.79	0.83
Number of schlcodes	77	76	103	102
Robust standard errors in parentheses				
* significant at 5%; ** significant at 1%				

Dependent Variable = Disclosures		
Invention Characteristics	Model 1	Model 2
INDFED	-0.04722	-6.09105
	[9.15752]	[9.76119]
TTO Characteristics		
TTOAGE	4.33669	3.3135
	[1.05497]**	[1.22250]**
TTOSIZE	5.76207	2.07647
	[0.61944]**	[0.66368]**
STP	0.5671	1.31829
	[0.23164]*	[0.40165]**
ACT		0.13019
		[0.01978]**
LNCAINE		0.52127
		[0.28407]
LNGROSS	2.35333	-0.2739
	[1.47801]	[1.77695]
Venture Capital Conditions		
LNVC	-2.72799	-2.70436
	[2.97568]	[2.87087]
LNVCSTAT	0.3151	0.36845
	[0.56003]	[0.78879]
Financial Market Conditions		
RLAVESP	0.19581	-0.12001
	[0.41608]	[0.49328]
RLAVENAS	0.01657	0.12934
	[0.28172]	[0.30149]
Constant	25.42453	71.03848
	[55.63390]	[55.07339]
Observations	845	571
Number of schlcode	103	102
R-squared Within	0.33803	0.3273
R-squared Between	0.51196	0.5714
R-squared Overall	0.48639	0.5481
Sigma_u	65.05711	68.7742
Sigma_e	28.16153	24.42217
Rho	0.84219	0.88802
F test that all u_i=0:	19.14	16.74
Prob > F =	0	0
(fraction of variance due to u_i)		
Standard errors in brackets		
* significant at 5%; ** significant at 1%		