

Predicting Research Productivity in STEM Faculty: The Role of Self-determined Motivation

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STUDY BACKGROUND

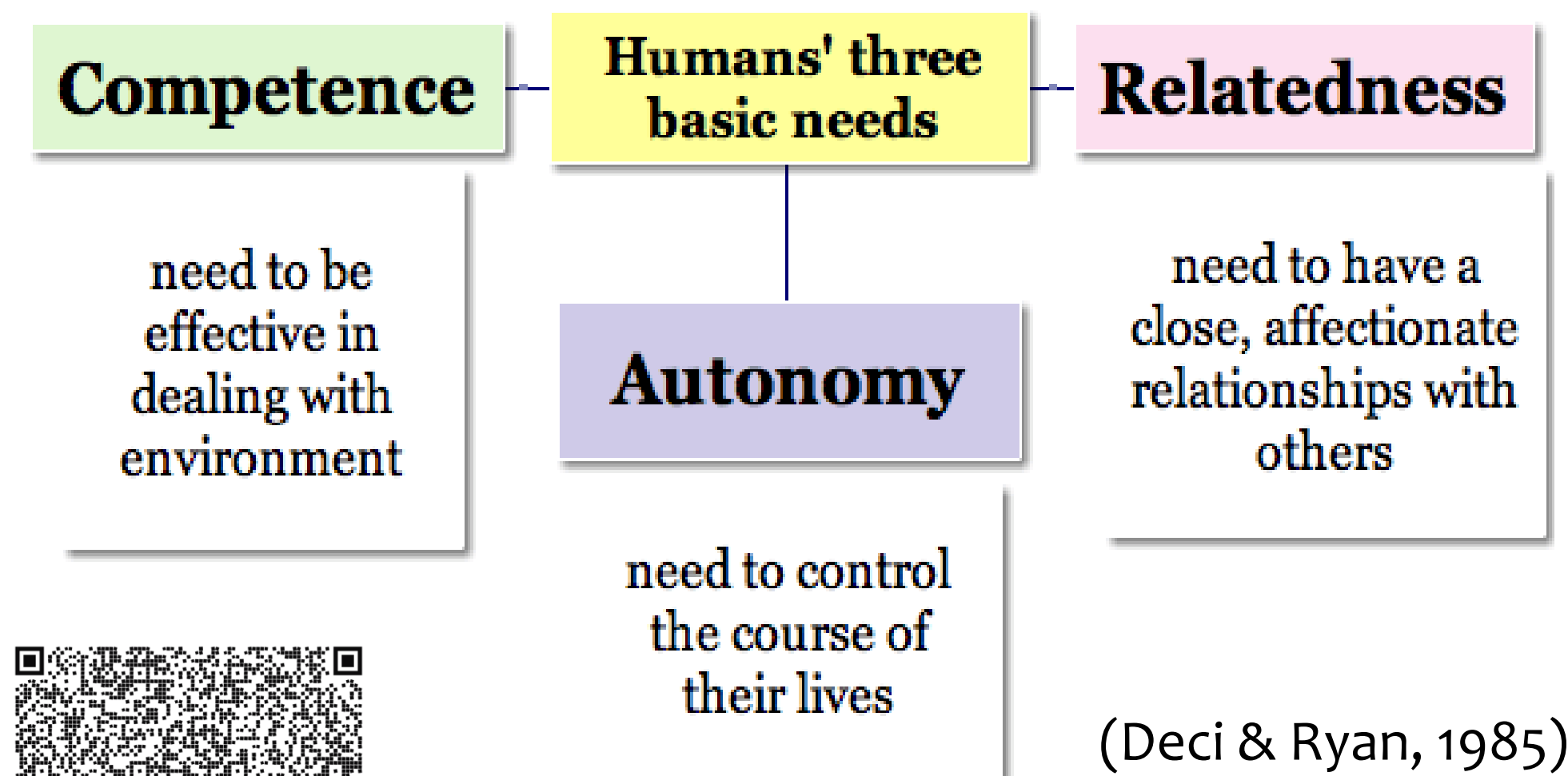
- Science, Technology, Engineering, and Mathematics (STEM) research has led to dramatic improvements, such as enhanced living standards and life expectancy, in the United States (NSB NSF, 2020a).
- Yet, the US share of the world STEM enterprise is dropping (37% to 25%) as other countries are investing more in research and development (NSB NSF, 2020b).
- Most studies to date examining predictors of faculty research productivity have focused on demographics, occupational characteristics, and social-environmental factors. (Hoppe et al., 2019; Stolzenberg et al., 2019; Sheridan et al., 2016)
- Bibliometrics applies statistics to examine patterns of authorship, publication, and literature use; for example, productivity is measured by publication of research results in peer-reviewed journals, and impact by citation counts (Sugimoto & Larivière, 2018)
- Few studies have examined faculty motivation to conduct research (what drives or energizes them to engage in scholarship), and fewer predicting bibliometric outcomes

PURPOSE OF STUDY

The current study aimed to examine how motivation predicts STEM faculty members' success and productivity in research, and specifically bibliometric success indicators.

THEORETICAL FRAMEWORK

Self-Determination Theory



STUDY SCALES

Descriptive Statistics and Reliabilities for Study Scales

Measure	# items	M	SD	Range	Skew	Kurtosis	α
Basic Needs							
Autonomy	4	4.11	0.66	1-5	-0.95	1.49	.83
Competence	4	4.23	0.58	1.75-5	-0.58	0.59	.83
Relatedness	4	3.93	0.71	1-5	-0.65	0.69	.86
Motivation							
Intrinsic	3	4.51	0.59	2-5	-1.37	2.08	.85
Identified	3	4.40	0.59	1.67-5	-1.17	1.70	.67
¹ Autonomous	6	4.45	0.55	2-5	-1.27	1.92	.86
Introjected	3	3.42	1.02	1-5	-0.46	-0.53	.85
External	3	3.53	0.83	1-5	-0.43	-0.25	.61
Amotivation	3	1.86	0.84	1-5	1.14	1.21	.82
Success							
Activity	4	3.53	0.76	1-5	-0.38	-0.09	.81
Publication	4	3.32	0.90	1-5	-0.28	-0.36	.88
Grants	4	3.15	1.00	1-5	-0.05	-0.71	.90
² Perceived overall	12	3.34	0.75	1.17-5	-0.13	-0.09	.91
³ Publications	1	7.75	7.13	1-33	1.50	1.80	-
Citations	1	27.20	39.71	0-225	2.42	6.55	-
Success: Covariates							
Career age	1	13.65	10.10	1-50	0.89	0.22	-
Research % on contract	1	40.36	20.53	0.2-100	0.59	0.51	-
Institutional support	7	2.94	0.77	1-5	0.00	-0.26	.83
Personal balance	4	3.15	0.67	1-5	-0.40	-0.04	.78
Professional balance	4	3.21	0.79	1-5	-0.19	-0.23	.82
Clear expectations	4	3.52	0.53	1-5	-0.79	1.75	.73
Collegiality	4	3.76	0.88	1-5	-0.91	0.63	.83

¹ Autonomous motivation is the average of all intrinsic and identified motivation items.

² Perceived overall is the average of activity, publication, and grant success measures.

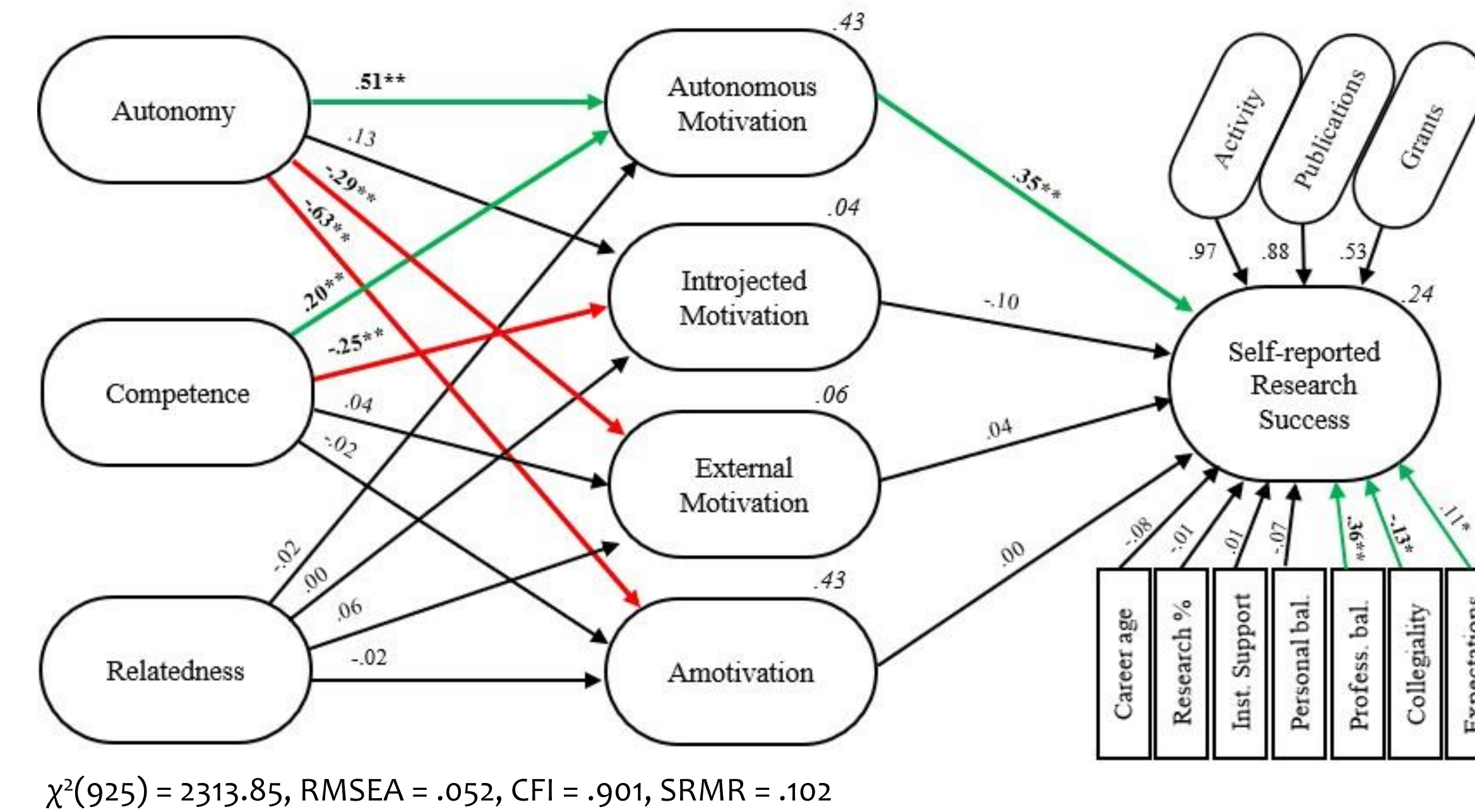
³ Faculty with more than 33 publications ($n = 12$) and more than 233 citations ($n = 12$) were outliers and removed from analysis.

METHODS

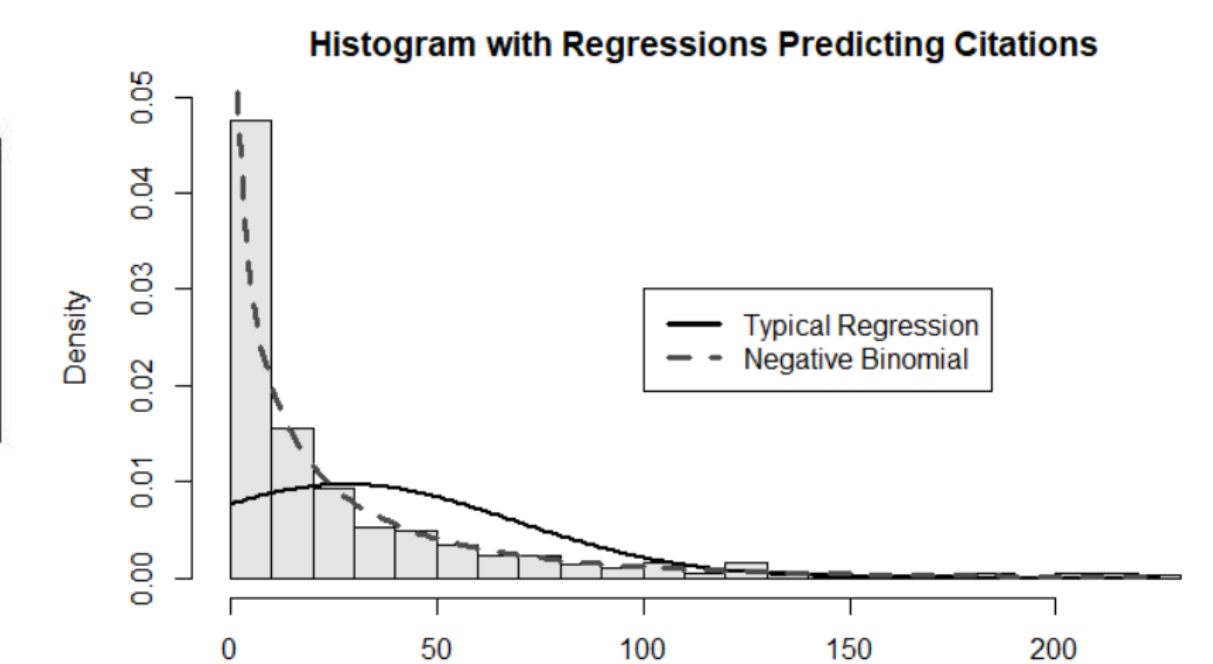
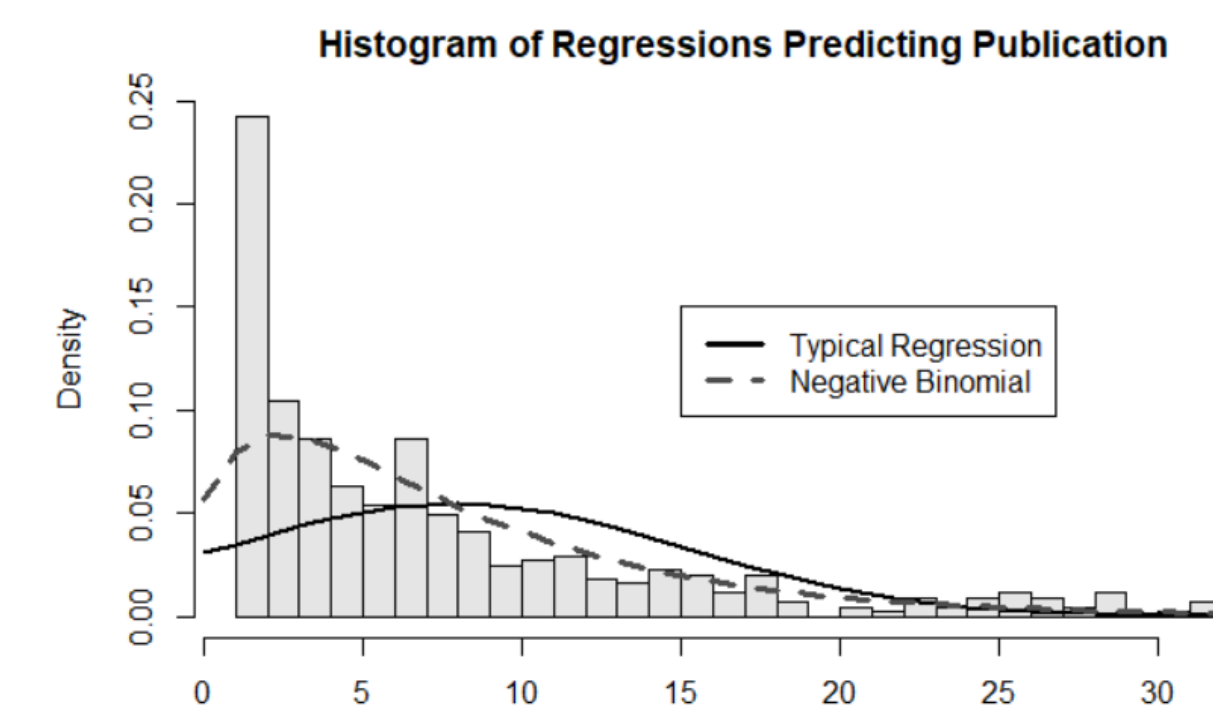
Participant Characteristics

		Count	Percent
Gender Identity	Man	388	59.6
	Woman	255	39.2
	I prefer not to respond	8	1.2
Racial Identification	White	531	81.6
	Asian	82	12.6
	Multiracial	15	2.3
	Other	11	1.7
	Black or African American	5	0.8
	No response	7	1.8
Ethnicity	Not of Hispanic, Latinx, or Spanish origin	602	92.5
	Yes, of Hispanic, Latinx, or Spanish origin	42	6.5
	No response	7	1.1
International	No	471	72.4
	Yes	176	27.0
	No response	4	0.6
Primary Disciplinary Area	Life sciences	178	27.3
	Social sciences	97	14.9
	Engineering	85	13.1
	Psychology	50	7.7
	Geoscience	46	7.1
	Mathematical sciences	36	5.5
	Chemistry	33	5.1
	Physics and astronomy	33	5.1
	STEM education learning research	30	4.6
	Computer and information science and engineering (CISE)	25	3.8
	Materials research	5	0.8
	No response	33	5.1
	Academic Rank	Assistant Professor	219
Associate Professor		178	27.3
Full Professor		212	32.6
Instructor/teaching professor		9	1.4
Research scientist/analyst		8	1.2
Other		25	3.8
Tenure Status	Tenured	376	57.8
	On tenure track but not tenured	209	32.1
	Not on tenure track	63	9.7
	Other	3	0.5

STRUCTURAL MODEL & REGRESSIONS



$\chi^2(925) = 2313.85$, RMSEA = .052, CFI = .901, SRMR = .102



Actual vs. Predicted Values for Regression Models

Publications	Actual	Predicted with Typical	Predicted with NB	Citations	Actual	Predicted	
						with Typical	with NB
1	66	2.99	30.91	5	16	1.64	11.95
3	46	8.35	33.62	10	9	2.55	7.77
5	28	31.95	29.21	25	4	15.71	3.65
10	11	40.87	15.72	50	3	2.03	1.58
15	10	1.44	7.60	75	1	0.00	0.81
25	4	0.01	1.73	100	1	0.00	0.45

CORRELATIONS & ANOVAS

Correlations

	1	2	3	4	5	6	7	8	9	10	11	12		
1. Autonomy	-													
2. Competence	.60**	-												
3. Relatedness	.56**	.40**	-											
4. Autonomous motivation	.54**	.47**	.40**	-										
5. Introjected motivation	-.03	-.11**	-.02	.05	-									
6. External motivation	-.14**	-.06	-.08*	-.15**	.18**	-								
7. Amotivation	-.52**	-.38**	-.37**	-.61**	.08*	.22**	-							
8. Perceived success	.32**	.39**	.27**	.31**	-.09*	-.02	-.22**	-						
9. Career age	.04	.12**	.02	.08*	-.13**	-.10*	.04	-.02	-					
10. Research % on contract	.08*	.12**	.04	.17**	-.02	.12**	-.06	.12**	-.07	-				
11. Institutional support	.28**	.12**	.35**	.12**	-.10**	.08	-.10*	.18**	-.08*	.10*	-			
12. Personal balance	.28**	.18**	.27**	.13**	-.13**	.00	-.11*	.18**	.05	.08*	.38**	-		
13. Professional balance	.40**	.39**	.31**	.21**	-.21**	.04	-.20**	.35**	.05	.16**	.44**	.67**		
14. Clear expectations	.30**	.25**	.41**	.18**	.00	.07	-.17**	.23**	-.08*	.07	.36**	.32**	.46**	
15. Collegiality	.32**	.09*	.52**	.18**	-.02	.03	-.25**	.09*	-.21**	-.02	.50**	.26**	.27**	.51**

* $p < .05$, ** $p < .01$

Rank Differences on Motivation and Research Success

Measure	Assist	Assoc	Full	F	Eta-sq
Basic Needs					
Autonomy	4.13(.63)	4.04(.71) ^a	4.21(.63) ^b	3.07**	.01
Competence	4.17(.59) ^a	4.23(.58)	4.34(.53) ^b	5.27**	.02
Relatedness	3.99(.64) ^a	3.81(.76) ^b	3.98(.73)	3.59*	.01
Motivation					
Autonomous	4.44(.51)	4.04(.50) ^a	4.55(.57) ^b	4.20*	.01
N. Introjected	3.59(.99) ^a	3.39(1.00)	3.13(1.03) ^b	4.31*	.01
External	3.60(.83) ^a	3.63(.79) ^a	3.41(.76) ^b	4.44*	.02
Amotivation	1.78(.79)	1.83(.81)	1.80(.81)	0.12	.00
Success					
Overall	3.45(.70)	3.18(.72) ^a	3.49(.75) ^b	8.71***	.03

CONCLUSIONS

- Using structural equation modeling, the basic psychological needs of autonomy and competence predicted autonomous motivation (enjoyment, value) that, in turn, was the strongest predictor of self-reported research productivity.
- Using negative binomial regression, autonomous motivation was the strongest predictor of faculty publications and citations, with a one-standard-deviation increase in autonomous motivation corresponding to an 11.63% increase or 8.67 more publications and a 22.57% increase or 34.79 more citations over a three-year period.
- These results are of relevance to higher education institutions aiming to support scholarly productivity in STEM faculty in identifying specific beneficial and detrimental aspects of faculty motivation that contribute to measurable gains in research activity.

