CESifo WORKING PAPERS

9675
2022

April 2022

A Model of the Effects of Gender Neutral Tenure Clock Stopping Policies on the Publication Strategies of Junior Faculty

Elisabeth Gugl, Moein Amini, Martin Farnham

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 9675*

A Model of the Effects of Gender Neutral Tenure Clock Stopping Policies on the Publication Strategies of Junior Faculty

Abstract

We model the decision of a junior faculty member where to send publications at various points along the tenure track. A single paper arrives exogenously at the start of each of three periods before the tenure decision is made. The researcher has the choice of submitting each paper to either a "Top" journal or a "Regular" journal. The probability of acceptance at a top journal is lower than at a regular journal, but the reward is greater. Researchers need a minimum of 1 top publication or 2 regular publications by the end of the three periods to get tenure. We show that, under reasonable assumptions about gendered childbearing and childrearing responsibilities, introduction of a gender neutral clock stopping (GNCS) policy induces men to submit more papers to top journals, while leaving women's submission strategies unchanged. This results in more top publications for men under a GNCS policy, while leaving women's publication records unchanged. Our model predictions are largely consistent with the empirical findings of Antecol et al. (2018). Our findings give insights into design of an important "family-friendly" university workplace policy with implications for the "leaky pipeline" in economics, whereby women are especially underrepresented at higher ranks in the discipline.

JEL-Codes: J080, J160, M510.

Keywords: gender neutral employment policies, tenure standards, gender roles, gender specific costs of child rearing, leaky pipeline.

Elisabeth Gugl
University of Victoria / BC / Canada
egugl@uvic.ca

Moein Amini
University of Victoria / BC / Canada
mohammadmoeinamini@uvic.ca

Martin Farnham
University of Victoria / BC / Canada
mfarnham@uvic.ca

March 2022
This working paper was prepared to complement a Festschrift article in honour of Richard Sturn. We thank an anonymous referee for suggestions that improved the paper.

1. Introduction

We model the effect of gender neutral tenure clock stopping (GNCS) policies on the publication strategies of male and female junior faculty and demonstrate how such policies may work to the advantage of men. Our model suggests that GNCS policies may contribute to a tenure gap between men and women and therefore a "leaky pipeline" that diminishes representation of women at higher academic ranks.

Many employers, in the presence of uncertainty, give employees a probationary period over which they demonstrate their productivity. Employees that meet the given productivity standard are then offered a promotion or contract renewal while those that don't meet the standard face expiration of their contract without renewal. Academic tenure is an example of a reward following a successful probationary period.

In settings where the probationary period is of a fixed length, taking parental leave or even having a child without leave could significantly impede an employee's chance of meeting the productivity standard. Therefore, prospective parents may be induced to delay fertility until the probationary period of their career ends. In an effort to be "family friendly" some workplaces offer "clock stopping" options with the probationary contract. "Clock stopping" allows the employee to extend the length of the probationary period to account for some period of lost productivity due to having a child.

Originally, tenure clock stopping policies applied only to mothers on the tenure track. However—ostensibly in the interest of gender equity—most universities offering clock-stopping options now do so to both mothers and fathers on faculty. In North America, gender neutral tenure clock stopping (GNCS) policies are the norm at research universities (Antecol, *et al.*, 2018). While well-intentioned, GNCS policies have recently drawn attention for the potentially differential impact they might have on the probability of obtaining tenure for men versus women.

In a world where men and women shared equally in the burden of pregnancy, giving birth, nursing, and caring for a baby, one might expect no differential effect of GNCS policies on tenure performance by gender. However, women biologically must bear the burden of pregnancy, giving birth, and nursing. Research (e.g., Rhoads and Rhoads, 2012) suggests that women faculty still spend significantly more time than male faculty on child rearing. This suggests that when male faculty stop their tenure clock for the birth of a child, they can continue to be highly research productive, whereas when (and even before) women stop their tenure clock, their childbearing and childrearing work is likely to significantly impede research output.

If 1) tenure cases are judged based on average annual productivity during the tenure-track probation period;[2] 2) average annual productivity of the tenure-probation period is measured as total research output (including that produced while the clock was stopped) divided by years on tenure track (not counting time when the clock was stopped); and 3) the tenure standard remains unchanged under a GNCS policy, then men should benefit more from GNCS policies than women. If, however, the tenure standard rises with the introduction of GNCS policies, then it is possible that such policies benefit men while hurting women. In fact, Antecol, *et al.* (2018) find that GNCS

[2] For a critical discussion of the measure of academic excellence using publication records, see Ferree and Zippel (2015).

policies at top 50 economics departments in the US raise the probability of men achieving tenure—at their first tenure-track job within 2 years of completing their PhD—by 17 percentage points. By contrast, such policies lower the probability of women achieving tenure at their first tenure-track job by 19 percentage points.

Antecol *et al.* point to the effect of GNCS policies on publication records as a key mechanism by which such policies benefit men's and hurt women's tenure prospects. Their findings suggest that the presence of GNCS policies lead men in top 50 departments to increase their number of publications in top 5 journals while leaving their number of regular (non-top-5) journal publications unchanged. This suggests that the ability to stop the tenure clock either 1) allows male junior faculty to take greater risks in their publication strategy; or 2) induces male junior faculty to invest more time in improving articles prior to submission. In this paper we focus on the former mechanism.

The option to stop the tenure clock in the future without incurring major childbearing and childrearing costs to his research productivity serves as a form of insurance for male junior faculty. Even an uncoupled man may be induced to follow a higher-risk, higher-reward publication strategy of increasing submissions to top journals, given the future option to stop his tenure clock. This option to stop the clock has little to no insurance value for female junior faculty, given that mothers bear the lion's share of the costs of having children and cannot easily parlay a stopped tenure clock into more publications.

In this paper we model the decision of a junior faculty member where to send publications at various points along the tenure track. A single paper arrives exogenously at the start of each of three periods before the tenure decision is made. The researcher has the choice of submitting each paper to either a "Top" journal or a "Regular" journal. The probability of acceptance at a top journal is lower than at a regular journal, but the reward is greater. Researchers need a minimum of 1 top publication or 2 regular publications by the end of the three periods to get tenure. We show that, under reasonable assumptions about childbearing and childrearing responsibilities, introduction of a GNCS policy induces men to submit more papers to top journals, while leaving women's submission strategies unchanged. This results in more top publications for men under a GNCS policy, while leaving women's publication records unchanged.

Our result matches the Antecol, *et al*. finding that men have more top 5 publications under GNCS policies but women have the same number and quality distribution of publications under GNCS. While our model does not include an endogenous tenure standard, one would expect that if GNCS policies were paired with a higher tenure standard (because the standard is rewritten or because tenure committees or outside referees raise their expectations of candidates in the presence of GNCS policies) this—through the mechanism outlined in our model—could simultaneously increase men's tenure chances and decrease women's tenure chances, as Antecol, *et al.* find.

Understanding differential effects by gender of university employment policies is important for addressing the underrepresentation of women in economics. Representation of women in economics departments has grown since the 1970s, but remains well below equality. Describing the situation in the United States, Lundberg and Stearns (2019) refer to "stalled progress", where the share of women in tenure or

tenure-track faculty positions climbed steadily through the early 2000s, but has since begun to decline. Researchers of the status of women in economics have noted a "leaky pipeline", whereby women tend to drop out of academic economics at various critical points in their career, including upon receipt of their Ph.D. and at the end of their tenure-probation period. While female underrepresentation in economics is no doubt caused by various factors including differences in preferences, differences in productivity, and outright bias, university employment policies can—for better or worse—play an important role in addressing the problem. This paper is intended to contribute to better understanding of how well-intentioned policies might make the problem worse.

2. The Status of Women in Economics

Women faculty are generally underrepresented in economics departments throughout the world. Lundberg and Stearns (2019) use data from the US Committee on the Status of Women in the Economics Profession to show that in 2017 women made up just 24% of the assistant professors at the 43 economics departments in the "Chairman's Group" of mostly top US departments. Furthermore, this represents a decline from 29% of assistant professors in 2009. Women in the same group of departments made up just 23% of associate professors and 13% of full professors.

In Canada, a survey of all economics departments found that women represented 15% of full professors, 28% of associate professors and 27% of assistant professors in 2018-2019 (Dhuey, 2021). In Europe, a study from the think tank Breugel (Birekeraho and Maniga, 2018) finds that women in economics departments at the top 20 universities in Europe represented 13% of full professors and 26% of lower academic ranks. Taking a broader view of Europe, Auriol *et al.* (2019) find that across all European economics departments in 2019, women represented 22.1% of full professors and 37-40% of lower ranks.

One clear pattern in the numbers noted above is that the share of women declines as one moves up through the academic ranks (e.g., from assistant to full professor in North America). The declining share of women as one moves up the ranks partly reflects a lagged response to the rising numbers of young women entering economics over time. The proportion of women getting PhDs in economics has risen since the 1970s, and it takes decades for that increase to pass through to upper ranks of the discipline. However, there is evidence of a "leaky pipeline"—that is greater differential dropout from academic economics positions by women than by men—which also contributes to the declining fraction of women as one moves up the ranks of faculty. This "leakage" can be due, among other things, to women failing to get tenure.

In the US, Ginther and Kahn (2004) find that women are less likely to get tenure than men, and take longer than men to get tenure. They also find that the presence of young children in a woman's household reduces the probability of promotion. 10 years after receiving their PhD, women in economics are 21% less likely than men to have a tenured academic job. By contrast, this difference is 8% in other social sciences, and there is no significant difference in this measure between men and women in the sciences. Chen *et al.* (2016) follow a single cohort of PhD graduates (from 2008) and find that women are 10% less likely than men to have achieved tenure within eight years of earning their PhD.

Morgan *et al.* (2021) investigate the impact of parenthood on research productivity in computer science, business, and history departments in the US and Canada. They find that parents are more productive than non- parents before having children. But they find that women suffer a significant productivity reduction upon having children, while men experience no change in productivity. Morgan *et al.* argue that most of the productivity gap between men and women can be attributed to differential effects of parenthood by gender.

While most evidence of a leaky pipeline has been produced using US data, Joecks *et al.* (2014) and Auriol *et al.* (2019), both find evidence of a leaky pipeline in Europe. Krapf *et al.* use a survey of approximately 10,000 REPEC registered economists from dozens of countries and a conditional difference-in-difference approach to estimate the productivity costs of childbearing on male and female economists, and find that each child reduces the productivity of female economists by about 10% per year until the child is a teenager. Untenured men's research productivity is increased by fatherhood. Together, these results suggest that parenthood contributes to the leaky pipeline in economics.

Other research suggests that Science Technology Engineering and Math (STEM) fields are also subject to the leaky pipeline (see Casad, *et al.*, 2020 for a discussion). This suggests that the concerns we raise may be applicable beyond the field of economics.[3]

Tenure clock stopping policies have often been proposed as a way to reduce the productivity disadvantage that motherhood confers on female academics. If they worked as intended, such policies could reduce the leaky pipeline in economics and other fields. However, as the findings of Antecol *et al.* suggest, gender neutral clock stopping policies may actually exacerbate the problem of the leaky pipeline by inducing junior male academics to pursue higher risk, higher reward publication strategies while barely compensating women for the cost of bearing a child and rearing an infant. In the next section we model the publication strategy of junior academics on tenure track and show how GNCS policies alter these incentives in ways that confer a relative tenure advantage on men.

3. The Model

Consider a junior academic who is hired into a tenure track position at a university. We abstract from decisions about the type of research that the academic performs and focus instead on decisions about aggressiveness of the submission strategy. We assume that new papers arrive exogenously at the beginning of 3 periods (all pre-tenure), so that the maximum number of publications in the academic's tenure packet is 3. Papers can be submitted to either a top journal or a regular journal. We denote journal *submissions* with T for top and R for regular; we denote journal *publications* with *t* for top and *r* for regular. Papers are *ex ante* identical in quality across faculty members, though *ex post* publication quality will vary.

We assume that decisions at journals take the same time, no matter whether a paper is submitted to a top journal (T) or a regular journal (R). However, there is a higher probability that a paper is accepted at a regular journal than a top journal, given by

[3] For a broader discussion of gender inequality in academia, see the special issue on Gender Equality in Higher Education and Research in the *Journal of Gender Studies* (v31, no1, 2022)

$\pi_t < \pi_r$ (Assumption 1)

We assume that once a paper has been rejected by a top journal, it will always be rejected by a top journal in subsequent submissions.[4] We further assume that the probability of getting an acceptance at a regular journal is not impacted by previous rejections, but that an academic can only send a paper to regular journals twice. This means that the researcher only chooses the publication strategy of a paper in the period it is produced. After the first rejection, the submission strategy in subsequent periods is predetermined.

Table 1: Possible submission strategies

Paper	**Arrival**	**Submission in period 1**	**Submission in period 2**	**Submission in period 3**
A	Period 1	T	R if rejected previously	R if rejected previously
A	Period 1	R	R if rejected previously	No longer able to submit
B	Period 2		T or R	R if rejected previously
C	Period 3			T or R

Academics are interested in two things: 1) getting tenure; and 2) the quality of their CV. *After tenure is secured*, the payoff of publishing in a top journal is given by *h* and the payoff of publishing in a regular journal is given by *l*, where

$h > l$ and $\pi_t h > \pi_r l$. (Assumption 2)

We assume that it is more likely to get two papers accepted in regular journals than to get one paper published in a top journal, such that

$\pi_t < \pi_r^2$. (Assumption 3)

We assume that the pre-tenure academic pursues a publication strategy that first maximizes the probability of getting tenure and, once the tenure standard is met, then maximizes the expected payoff (quality of the CV). Lemma 1 specifies this strategy.

Lemma 1. *Given Assumption 2, the optimal publication strategy after meeting or exceeding the tenure standard is to send any new papers to a top journal first.*

We assume that the tenure standard is one publication in a top journal or two publications in regular journals. Table 2 makes this clear.

[4] One can think of the review process as revealing information about the quality of the research, such that a rejection from a top journal conveys to the author that the paper is not top journal material.

Table 2. Publication Records versus the Tenure Standard

Publication record	Meets or exceeds tenure standard	Does not meet tenure standard
t, t, t	X	
t, t, r	X	
t, r, r	X	
r, r, r	X	
t, t	X	
t, r	X	
r, r	X	
t	X	
r		X
0		X

Next, we specify for each of the three papers where to send the paper first. Denote the strategy for first submission of paper *i*, given a publication record from previous periods, as $s_i(\cdot)$. In period 1, there is no publication record, so the strategy for submitting paper A is either $s_A = R$ or $s_A = T$.

Proposition 1. *The academic sends paper A to a top journal in the first period;* $s_A = T$.

Proof. Given that the academic always has the option to send the first paper two more times to a regular journal before going up for tenure, it makes no sense to throw away the shot at publishing the paper in a top journal by sending it to a regular journal right away. Denote the probability of getting tenure by sending paper A first to a regular journal by $Prob(tenure|s_A = R)$. We know that the researcher's probability of getting tenure sending the paper to a top journal first is at least $\pi_t + (1 - \pi_t)Prob(tenure|s_A = R)$. Think of this probability as a linear combination of $Prob(tenure|s_A = R)$ and 1, and thus we know $\pi_t + (1 - \pi_t)Prob(tenure|s_A = R) > Prob(tenure|s_A = R)$. So, the academic always sends their first paper (paper A) to a top journal.[5]

Recall that a paper may only be submitted to a top journal once and to a regular journal twice. Hence the optimal strategy for paper A is always to send it to a top journal in period 1 and then (if rejected) to a regular journal in periods 2 and 3.

Given Proposition 1, we know that at the beginning of the second period there can only be two possible publication outcomes: either paper A was accepted at a top journal or it was rejected. We now turn to period 3 knowing that at this point the only possible outcomes for paper A are a publication in a top journal (acceptance in the first period), a

[5] Note that whatever happens to the other two papers can be done independently of what happens to the first paper. However, if the first paper is first sent to a regular journal, then it is possible that in the third period the academic will have no publications and their only shot at tenure will be to get the remaining two papers published. The probability of this happening is much lower with two papers than when three papers can be sent out:
$\pi_R^2 < \pi_R^3 + 3\pi_R^2(1 - \pi_R)$
$\pi_R^2 < \pi_R^2 + 2\pi_R^2(1 - \pi_R)$.

publication in a regular journal (acceptance in the second period), or two rejections with one more shot at a regular journal remaining.

Proposition 2. *If, at the beginning of period 3, the academic meets the tenure standard, then by Lemma 1, the academic sends paper C to a top journal. If at the beginning of period 3 the academic does not yet meet the tenure standard, but has one publication in a regular journal, they send paper C to a regular journal. If they have 3 papers left to submit (they received only rejections before period 3), then they send all three papers to regular journals.*

Proof. If the academic starts period 3 with one publication in a regular journal and a rejection of the other paper, that is because either paper A was first rejected by a top journal and then rejected by a regular journal with one more shot at a regular journal or paper B was rejected once while paper A was accepted by a regular journal after having been rejected by a top journal.

Given that the other unpublished paper can no longer be sent to a top journal, sending that paper and paper C to a regular journal yields a probability of tenure of $Prob(tenure|s_C(r) = R) = 2\pi_r(1-\pi_r) + \pi_r^2$ while the probability of getting tenure sending paper C to a top journal is $Prob(tenure|s_C(r) = T) = \pi_r(1-\pi_t) + \pi_t$. Note that $2\pi_r(1-\pi_r) + \pi_r^2$ can be written as $\pi_r(1-\pi_r) + \pi_r(1-\pi_r) + \pi_r\pi_r = \pi_r(1-\pi_r) + \pi_r$. By Assumption (1), $\pi_r(1-\pi_r) + \pi_r > \pi_r(1-\pi_t) + \pi_t$ and hence $s_C(r) = R$. (Alternatively, think of a linear combination with endpoints $(\pi_r, 1)$, where the weight on 1 is higher with π_r than with π_t.)

If the academic starts period 3 with no publications, then papers A and B must go to regular journals, and the probability of getting tenure by sending paper C to a regular journal is $Prob(tenure|s_C(0) = R) = 3(1-\pi_r)\pi_r^2 + \pi_r^3$ while the probability of getting tenure by sending paper C to a top journal is $Prob(tenure|s_C(0) = T) = \pi_t + (1-\pi_t)\pi_r^2$. For the researcher to send paper C to a top journal we must have

$$\pi_t + (1-\pi_t)\pi_r^2 \geq 3(1-\pi_r)\pi_r^2 + \pi_r^3.$$

Note that

$$3(1-\pi_r)\pi_r^2 + \pi_r^3 = 2(1-\pi_r)\pi_r^2 + \pi_r^2.$$

Rearranging, this yields

$$\pi_t(1-\pi_r^2) + \pi_r^2 \geq 2(1-\pi_r)\pi_r^2 + \pi_r^2$$

or equivalently,

$$\pi_t(1-\pi_r)(1+\pi_r) \geq 2(1-\pi_r)\pi_r^2, \text{ so } \pi_t \geq \frac{2\pi_r^2}{1+\pi_r}.$$

Note that it is possible for this inequality to hold given Assumption (1). However, by Assumption (3), $\pi_t < \pi_r^2$. So, the highest value the LHS can take on is epsilon smaller than π_r^2. But $\pi_r^2 \geq \frac{2\pi_r^2}{1+\pi_r}$ or, equivalently, $1 \geq \frac{2}{1+\pi_r}$ is a contradiction as the RHS is always greater 1. Therefore, it never pays to send paper C to a top journal given only rejections up to this point.

Next, we focus on the publication strategy for Paper B, knowing that the academic always sends the paper to a regular journal in the third period and given the optimal publication strategy for Paper C.

Proposition 3. *If the academic starts the second period with a publication in a top journal, they send Paper B to a top journal by Lemma 1. If the academic starts the second period with no publication, then they send Paper B to a regular journal.*

Proof. Let's focus on the possible outcomes that the academic would find themselves in at the beginning of period 2. At this point, they have learned the outcome of the first submission of paper A which is either T, or 0 by Proposition 1. If T, then they meet the tenure standard and would send paper B to a top journal by Lemma 1.

If they sent paper A to a top journal and were rejected, then sending paper B to a top journal yields a probability of getting tenure

$$\begin{aligned} &Prob(tenure|s_B(0) = T) \\ &\quad = \pi_t + (1-\pi_t)\pi_r Prob(tenure|s_C(r) = R) \\ &\quad + (1-\pi_t)(1-\pi_r)Prob(tenure|s_C(0) = R) \end{aligned}$$

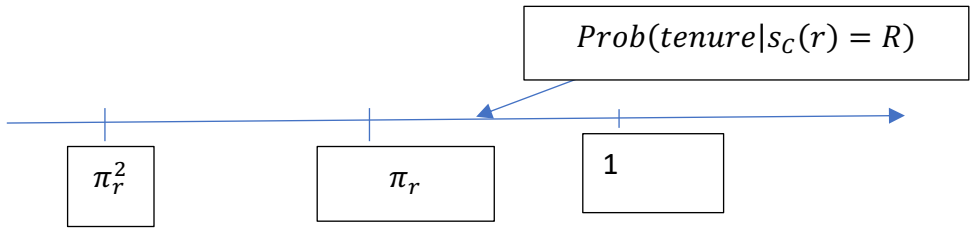
If, instead, they send the paper to a regular journal, the probability of tenure is

$$\begin{aligned} &Prob(tenure|s_B(0) = R) \\ &\quad = \pi_r^2 + 2(1-\pi_r)\pi_r Prob(tenure|s_C(r) = R) \\ &\quad + (1-\pi_r)^2 Prob(tenure|s_C(0) = R) \end{aligned}$$

Note that we can think of the expressions describing the probability associated with each period 2 action (T or R) as a weighted sum of $\big(1, Prob(tenure|s_C(r) = R), Prob(tenure|s_C(0) = R)\big)$.

Next, we show that $Prob(tenure|s_C(0) = R) < Prob(tenure|s_C(r) = R) < 1$. To see that this is true, $Prob(tenure|s_C(0) = R) = \pi_r(\pi_r(1-\pi_r) + \pi_r) + (1-\pi_r)\pi_r^2 = \pi_r Prob(tenure|s_C(r) = R) + (1-\pi_r)\pi_r^2$.

Figure 1: The probability of getting tenure in period 3 with one publication in a regular journal from period 2



So we can think of $Prob(tenure|s_C(0) = R)$ as a linear combination of π_r^2 and $Prob(tenure|s_C(r) = R)$ but we know $Prob(tenure|s_C(r) = R) > \pi_R^2$ and hence $Prob(tenure|s_C(0) = R) < Prob(tenure|s_C(r) = R)$.

If we can show that $Prob(tenure|s_B(0) = R)$ carries higher weights for the first two terms and a lower weight on the last than $Prob(tenure|s_B(0) = T)$ we can conclude that $Prob(tenure|s_B(0) = R) > Prob(tenure|s_B(0) = T)$. To prove this, first note that $\pi_t + (1-\pi_t)\pi_r + (1-\pi_t)(1-\pi_r) = 1$, and $\pi_r^2 + 2(1-\pi_r)\pi_r + (1-\pi_r)^2 = \big(\pi_r + (1-\pi_r)\big)^2 = 1$.

By Assumption 3 we know that $\pi_t < \pi_r^2$ and by Assumption 1 we know that $(1-\pi_t)(1-\pi_r) > (1-\pi_r)^2$. So we can think of $Prob(tenure|s_B(0) = R)$ as reweighting towards the better payoffs and thus $Prob(tenure|s_B(0) = R) > Prob(tenure|s_B(0) = T)$.[6]

Table 3 summarizes the optimal publication strategy for the academic.

Table 3. Optimal publication strategy

Paper	**Arrival**	**Submission in period 1**	**Submission in period 2**	**Submission in period 3**
A	Period 1	T	R if rejected previously	R if rejected previously
B	Period 2		T if 1st paper published, R otherwise	R if rejected previously
C	Period 3			T if meeting or exceeding tenure standard, R otherwise

Table 4 lists the probabilities of achieving different publication records by the time of the tenure decision. The last column indicates how often a paper is submitted and to which journal it is submitted. For example, (T,R) for paper B means that it goes to a top journal in period 2 and, after being rejected there, to a regular journal in period 3.

[6] See Appendix A.1. for the general result of reweighting sums.

Table 4: Probability of reaching a certain publication record by tenure decision

Publication record at tenure decision	**Probability**	**Strategy (paper A),(paper B), (paper C)**
Meets or exceeds tenure standard		
t, t, t	π_t^3	(T),(T),(T)
t, t, r	$\pi_t^2(1-\pi_t)\pi_r$	(T),(T,R),(T)
t, r, r	$(1-\pi_t)\pi_r^2\pi_t$	(T,R),(R),(T)
r, r, r	$(1-\pi_t)(1-\pi_r)\pi_r^3(3-\pi_r)$	(T,R),(R,R),(R) or (T,R,R), (R),(R) or (T,R,R), (R,R),(R)
t, t	$\pi_t^2(1-\pi_t)(2-\pi_r)$	(T),(T,R),(T) or (T),(T),(T)
t, r	$\pi_t\pi_r(1-\pi_t)^2$	(T),(T,R),(T)
r, r	$(1-\pi_t)\pi_r^2[(1-\pi_t)+4(1-\pi_r)^2+3(1-\pi_r)^3]$	(T,R,R),(R,R),(R) or (T,R),(R),(T) or (T,R),(R,R),(R) or (T,R,R),(R),(R)
t	$\pi_t(1-\pi_t)^2(1-\pi_r)$	(T),(T,R),(T)
Does not meet tenure standard		
r	$(1-\pi_t)\pi_r(1-\pi_r)^3(5-3\pi_r)$	(T,R),(R,R),(R) Or (T,R,R),(R),(R) Or (T,R,R),(R,R),(R)
0	$(1-\pi_t)(1-\pi_r)^5$	(T,R,R),(R,R),(R)

4. Child Bearing and Rearing Before Tenure

Various studies (e.g., Krapf, *et al.* 2017; Morgan, *et al.* 2021) suggest that becoming a parent dramatically slows productivity of female academics in the short run while having small negative (or even positive) effects on male academics. In the absence of any compensating policy, we assume that Paper B never arrives for a female academic who chooses to have a child, and so she ends up with one less potential publication while on the tenure clock. Given this high cost of caring for a child while on tenure track, all else equal, our model predicts fewer female academics having children than would be observed under a clock stopping policy.

A female-only clock stopping policy: For female academics who choose to have a child, we assume that their tenure clock is stopped for one year. Such a policy freezes any actions in time and unfreezes them after the clock starts ticking again. So, there will be no change in behaviour for female academics other than an increase in the number having children before tenure. The female publication strategy will remain as in Table 3, but with a blank (no action) year inserted somewhere between the beginning of period 1 and the end of period 3 for those who have a child.

A gender-neutral clock stopping policy: For female academics, the effect will be as for a female-only policy (see above). Here we focus on the fraction of male academics who view the policy as insurance against rejection from a top journal. It is well established (e.g., Krapf, *et al.* 2017; Morgan, *et al.* 2021) that the arrival of a child pre-tenure has little impact

on the research productivity of male academics on average. Taking advantage of the clock stopping *de facto* adds another period to the academic's pre-tenure clock. So conditional on not getting a top journal publication after the first period, the academic can insure himself against a rejection from a top journal in the second period by leaving the option open to stop the clock at the beginning of period 3. This leads to a submission of the second paper to a top journal after observing a rejection of the first paper from a top journal. Given that, in aggregate, more male tenure-track academics send their second papers to a top journal, this results in more top journal publications by junior male researchers in any given department where a GNCS policy is in place compared with a department with no GNCS policy in place. Since the clock stopping policy would be used only in the event that the second paper gets rejected, not everybody who uses the stop the clock policy *as insurance*, will actually *claim* the additional year. Antecol *et al.* (2018) make the point that "tenure clock stopping policies may affect tenure and publication outcomes even for individuals who ultimately do not have a child prior to tenure."[7]

Proposition 4: Using GNCS as insurance, an academic submits both papers A and B to top journals first. Paper C goes to a top journal if the academic meets or exceeds the tenure status by the arrival of period 3 and to a regular journal otherwise. Table 5 lists the optimal strategy using GNCS as insurance.

Table 5: Optimal strategy using GNCS as insurance

Paper	**Arrival**	**Submission in period 1**	**Submission in period 2**	**Submission in period 3**	**Submission in period 4 (take up if tenure standard not yet met after period 2)**
A	Period 1	T	R if rejected previously	R if rejected previously	No longer available
B	Period 2		T	R if rejected previously	R if rejected previously
C	Period 3			T if meeting or exceeding tenure standard, R otherwise	R if rejected previously

$Proof. s_A = T, s_B(t) = s_B(0) = T$ for the same reason explained in Proposition 1. $s_C(t) = s_C(t,t) = s_C(r,t) = T$ by Lemma 1. We prove $s_C(0) = s_C(r) = R$ in A.2.1 in the appendix.

[7] In fact, female academics with a stay-at-home partner could employ the same strategy—using GNCS as insurance against a top journal rejection—that we attribute here to a fraction of male academics. A GNCS policy will favour men so long as the fraction of men who use it to enhance their publication record exceeds the fraction of women who use it similarly.

Note that the male academic will go up for tenure without taking the extra year if they meet the tenure standard at the beginning of period 3; that is, they already have 2t, tr, or t. Using the clock stopping policy as insurance, it is now possible to end up with a paper in a regular journal and a paper in a top journal at the beginning of period 3, because even if the first paper gets rejected from a top journal the academic would now send the second paper to a top journal first. This aggressive publication strategy would not be observed for someone who actually bears the cost of child rearing and thus the strategy of Table 3 applies to female academics under a GNCS policy.

Theorem 1. Using the GNCS policy as insurance more than doubles the probability of publishing 2 top journal articles and one publication in a regular journal after three periods and increases the probability of 2 top journal publications after three periods.

Proof. The probability that the academic ends up with 2 top journal publications and one publication in a regular journal after three periods more than doubles from $\pi_t^2(1-\pi_t)\pi_r$ to $2\pi_t^2(1-\pi_t)\pi_r+\pi_t^2(1-\pi_t)\pi_r(1-\pi_r)$. The probability of 2 top journal publications after three periods increases from $\pi_t^2(1-\pi_t)(2-\pi_r)$ to $\pi_t^2(1-\pi_t)(2-\pi_r)+\pi_t^2(1-\pi_t)(1-\pi_r)^2$.

In the real world, one important way that stopping the clock without taking on heavy childrearing burdens helps male faculty is by allowing them to produce more *research* before their tenure packet is submitted. This additional research output translates into more publications or better publications if they put the extra time into improving the quality of existing projects. In our model under a GNCS policy, male and female faculty produce the *same* amount of research regardless of fertility. Everyone produces 3 articles. While that aspect of the model is unrealistic, the fact that men in the model who stop the clock get an extra year of submitting to journals (while women who stop the clock don't) captures the essence of the productivity imbalance induced by a GNCS policy.

By holding research output constant across men and women, our modelling approach focuses attention on a less obvious but possibly equally important imbalance induced by GNCS policies. Not only do they provide men with additional time to do research, but they provide men with a valuable option to stop the clock in the future, which allows men early in their tenure clock to pursue more aggressive publication strategies. In reality, the first couple years on the tenure clock are the critical time when dissertations are converted into publications and important choices are made about how high to pitch those articles. Even unpartnered men may adopt a more aggressive publication strategy early in the tenure clock, given the knowledge that they may have the option to stop the clock down the road. And as should be clear, even men who ultimately don't stop the clock, benefit from the option to stop the clock in the future, because it means submission strategies that would be too risky without the option are now essentially insured by the option. For female faculty under GNCS policies and under reasonable assumptions about the childcare workload of new mothers, the option to stop the clock in the future has no value and therefore leads to no change in submission strategies.

V. Conclusion

We present a model that is complex enough to capture many of the dynamic aspects of journal submission strategy and the production of academic journals, but that is also

tractable. Our paper provides a theoretical underpinning for the empirical results of Antecol *et al.* that (1) gender neutral clock-stopping leads to an increase in top 5 publications by men; (2) the same policies have no effect on publications by women (top 5 or total number); and (3) men who successfully get tenure at their first institution do not appear to have taken extra time to do so.

We show that a GNCS policy provides a form of insurance for men against rejection from top journals, and that men respond to the policy by pursuing a more aggressive submission strategy. By contrast, women's submission strategies are left unchanged by a GNCS policy. Stopping the clock for women just makes up for the time lost to becoming a mother and caring for an infant while for men, taking the extra year serves as a safeguard against early rejections of papers sent to top journals.

Our model predicts that such a response by male academics to GNCS will lead to more publications in top journals early in their career, and that many of those additional top publications will accrue to men who do not actually stop their tenure clock. This is consistent with the Antecol *et al.* finding that GNCS does not have a statistically significant effect on the length of time men take to earn tenure.

Our findings add to concerns that gender neutral tenure clock stopping policies may contribute to the leaky pipeline in academia (especially economics and the physical sciences) by disadvantaging women relative to men. These policies may need to be revisited. Alternative policies could include female only clock stopping policies, stricter requirements for faculty to demonstrate that they are the primary caregiver to a child, differential tenure standards for women who have had children while on the tenure clock, or scaling up of research output in the tenure packets of documented primary caregivers.

Bibliography

Antecol, Heather and K. Bedard and J. Stearns (2018). "Equal but Inequitable: Who Benefits from Gender-Neutral Tenure Clock Stopping Policies?" The American Economic Review v108, no9. https://www.jstor.org/stable/26528532

Auriol, E. and G. Friebel, and S. Wilhelm (2019). "Women in European Economics." Blog post.

Birekeraho, Ariane and Paola Maniga (2018). "How many female economics professors in top European Universities?" Blog post. https://www.bruegel.org/2018/03/how-many-female-economist-professors-in-top-european-universities/

Buckles, Kasey (2019). "Fixing the Leaky Pipeline: Strategies for Making Economics Work for Women at Every Stage." Journal of Economics Perspectives, v33 no1. https://www.jstor.org/stable/26566976

Casad, Bettina J., Jillian E. Franks, Christina E. Garasky, Melinda M. Kittleman, Alanna C. Roesler, Deirdre Y. Hall, Zachary W. Petzel (2020). "Gender Inequality in Academia:

Problems and solutions for women faculty in STEM." Journal of Neuroscience Research, v99 no1.

Chen, Jihui and Myongjin Kim and Qihong Liu (2016). "Do Female Professors Survive the 19th Century Tenure System?: Evidence from the Economics PhD Class of 2008." Unpublished manuscript. http://web.apsanet.org/wp-content/uploads/sites/4/2016/04/Draft-of-Economics-Cohort-Study.pdf

Myra Marx Ferree, Kathrin Zippel, (2015). "Gender Equality in the Age of Academic Capitalism: Cassandra and Pollyanna Interpret University Restructuring". Social Politics: International Studies in Gender, State & Society, v22, no4, https://doi.org/10.1093/sp/jxv039

Ginther, Donna and Shulamit Kahn (2004). "Women in Economics: Moving Up or Falling Off the Academic Career Ladder? Journal of Economic Perspectives, v18, no3. https://www.aeaweb.org/articles?id=10.1257/0895330042162386

Krapf, Matthias, Heinrich W. Ursprung, and Christian Zimmermann (2017). "Parenthood and Productivity of Highly Skilled Labor: Evidence from the groves of academe." Journal of Economic Behaviour and Organization, v140. https://doi.org/10.1016/j.jebo.2017.05.010

Lundberg, Shelley and J. Stearns, (2019). "Women in Economics: Stalled Progress." Journal of Economic Perspectives, v33 no1. https://www.jstor.org/stable/26566974

Morgan, Alison C., Samuel F. Way, Michael J.D. Hoefer, Daniel B. Larremore, Mirta Galesic, Aaron Clauset (2021). "The unequal impact of parenthood in academia." Science Advances, v7, no9. https://europepmc.org/article/med/33627417

Appendix

A1. Weighted sums; used in proof of Proposition 3

Denote the different payoffs as (x, y, z) with $x > y > z$. Let the weights be a, b, c, where $a + b + c = 1$ and hence $b = 1 - a - b$. This yields the following expression:

$$f(a, c) = ax + (1 - a - c)y + cz$$

Differentiate this expression with respect to a and c, where $da > 0$ and $dc < 0$.

$$df(a, c) = xda - (da + dc)y + zdc$$

Hence

$$df(a, c) = (x - y)da - (y - z)dc$$

Since $da > 0$ and $dc < 0$ and $(x - y), (y - z) > 0$, $df(a, c) > 0$.

A.2 Stop the clock optimal strategies

A2.1. Proof that $Prob(tenure|s_C(r) = R) > Prob(tenure|s_C(r) = T)$ with 4 periods

If GNCS policy is used as insurance, then the academic always sends paper B to a top journal in the second period. This means that the academic announces the take up of the policy at the beginning of the third period if they either end up with one publication in a regular journal or zero publications after the first two periods. Ending up with one regular journal publication at the beginning of period 3 is the result of paper A being rejected at a top journal, and then accepted at a regular journal in the second period, while paper B got rejected at a top journal in the second period.

With this in mind, there are only 2 papers to be sent out in period 3 and possibly period 4.

If paper C is sent to a top journal in period 3, then the probability of tenure after period 4 is

$$Prob(tenure|s_C(r) = T) = \pi_t(1 - \pi_r) + \pi_r(1 - \pi_t) + \pi_t\pi_r + (1 - \pi_r)(1 - \pi_t)(\pi_r^2 + 2\pi_r(1 - \pi_r))$$

If paper C is sent to a regular journal in period 3, then the probability of tenure after period 4 is

$$Prob(tenure|s_C(r) = R) = 2\pi_r(1 - \pi_r) + \pi_r^2 + (1 - \pi_r)^2(\pi_r^2 + 2\pi_r(1 - \pi_r))$$

The academic chooses to send paper C to a top journal in period 3 iff

$\pi_t(1 - \pi_r) + \pi_r(1 - \pi_t) + \pi_t\pi_r + (1 - \pi_r)(1 - \pi_t)(\pi_r^2 + 2\pi_r(1 - \pi_r)) \geq 2\pi_r(1 - \pi_r) + \pi_r^2 + (1 - \pi_r)^2(\pi_r^2 + 2\pi_r(1 - \pi_r))$

or equivalently iff

$\pi_r(\pi_r - \pi_t) + (1 - \pi_r)(\pi_r - \pi_t)(\pi_r^2 + 2\pi_r(1 - \pi_r)) \geq (1 - \pi_r)(\pi_r - \pi_t) + \pi_r(\pi_r - \pi_t)$ or equivalently iff

$$(1 - \pi_r)(\pi_r - \pi_t)(\pi_r^2 + 2\pi_r(1 - \pi_r)) \geq (1 - \pi_r)(\pi_r - \pi_t)$$

By Assumption *1* $(\pi_r - \pi_t) > 1$. Since $\pi_r^2 + 2\pi_r(1 - \pi_r)) < 1$ this is a contradiction and hence the researcher sends paper C to a regular journal conditional on going into period 3 with one publication in a regular journal.

A.2.2. Proof that $Prob(tenure|s_C(0) = R) > Prob(tenure|s_C(0) = T)$ with 4 periods

Zero publications at the beginning of period 3 is the result of paper A being rejected at a top journal and rejected at a regular journal in the second period, while paper B is rejected at a top journal in the second period; the researcher has 3 papers left to send in period 3 and possibly 2 papers to send to a regular journal in period 4.

If paper C is sent to a top journal in period 3, then the probability of tenure after period 4 is

$$\begin{aligned} Prob(tenure|s_C(0) = T) \\ &= \pi_t + \pi_r^2(1-\pi_t) + (1-\pi_r)(1-\pi_t)\pi_r^2 \\ &+ (1-\pi_t)(1-\pi_r)\pi_r(\pi_r^2 + 2(1-\pi_r)\pi_r) + (1-\pi_r)^2\,(1-\pi_t)\pi_r^2 \end{aligned}$$

If paper C is sent to a regular journal in period 3, then the probability of tenure after period 4 is

$$\begin{aligned} Prob(tenure|s_C(0) = R) \\ &= \pi_r^3 + 3\pi_r^2(1-\pi_r) + (1-\pi_r)^2\pi_r^2 + (1-\pi_r)^2\pi_r(\pi_r^2 + 2(1-\pi_r)\pi_r) \\ &+ (1-\pi_r)^3\,\pi_r^2 + (1-\pi_r)^2\,\pi_r^2 \end{aligned}$$

Thus, the academic chooses to send paper C to a top journal in period 3 if and only if

$$\begin{aligned} &\pi_t + \pi_r^2(1-\pi_t) + (1-\pi_r)(1-\pi_t)\pi_r^2 + (1-\pi_t)(1-\pi_r)\pi_r(\pi_r^2 + 2(1-\pi_r)\pi_r) \\ &+ (1-\pi_r)^2\,(1-\pi_t)\pi_r^2 \\ &\geq \pi_r^3 + 3\pi_r^2(1-\pi_r) + (1-\pi_r)^2\pi_r^2 + (1-\pi_r)^2\pi_r(\pi_r^2 + 2(1-\pi_r)\pi_r) \\ &+ (1-\pi_r)^3\,\pi_r^2 + (1-\pi_r)^2\,\pi_r^2 \end{aligned}$$

Note that we can split up the second term on the RHS $3\pi_r^2(1-\pi_r) = 2\pi_r^2(1-\pi_r) + \pi_r^2(1-\pi_r)$

Collecting terms with common factors on both sides,

$$\begin{aligned} &\pi_t + (1-\pi_r)\pi_r^2(\pi_r - \pi_t) + \pi_r(1-\pi_r)(\pi_r - \pi_t)\big(\pi_r^2 + 2\pi_r(1-\pi_r)\big) + \pi_r^2(\pi_r - \pi_t) \\ &+ (1-\pi_r)^2\pi_r^2(\pi_r - \pi_t) \geq \pi_r^3 + 2\pi_r^2(1-\pi_r) + (1-\pi_r)^2\,\pi_r^2 \end{aligned}$$

Note that $\pi_r^2 + 2\pi_r(1-\pi_r) + (1-\pi_r)^2 = (\pi_r + (1-\pi_r))^2 = 1$ and hence we can write

$$\pi_t = \pi_t(\pi_r^2 + 2\pi_r(1-\pi_r) + (1-\pi_r)^2).$$

Using this equivalency in our inequality yields

$$\begin{aligned} &\pi_t(\pi_r^2 + 2\pi_r(1-\pi_r) + (1-\pi_r)^2) \\ &+ (\pi_r - \pi_t)\big((1-\pi_r)\pi_r^2 + \pi_r(1-\pi_r)\big(\pi_r^2 + 2\pi_r(1-\pi_r)\big) + \pi_r^2 \\ &+ (1-\pi_r)^2\pi_r^2\big) \geq \pi_r^3 + 2\pi_r^2(1-\pi_r) + (1-\pi_r)^2\,\pi_r^2 \end{aligned}$$

Factoring out common terms on both sides,

$$\begin{aligned} &(\pi_r - \pi_t)\Big((1-\pi_r)\pi_r^2 + \pi_r^2 + (1-\pi_r)^2\pi_r^2 + \pi_r(1-\pi_r)\big(\pi_r^2 + 2\pi_r(1-\pi_r)\big)\Big) \\ &\geq (\pi_r - \pi_t)(\pi_r^2 + 2\pi_r\,(1-\pi_r)) + (1-\pi_r)^2\,(\pi_r^2 - \pi_t) \end{aligned}$$

$$\begin{aligned} &(\pi_r - \pi_t)((1-\pi_r)\pi_r^2 + \pi_r(1-\pi_r)\pi_r^2 + (1-\pi_r)^2\pi_r^2) \\ &\geq (\pi_r - \pi_t)2\pi_r\,(1-\pi_r)(1-\pi_r(1-\pi_r)) + (1-\pi_r)^2\,(\pi_r^2 - \pi_t) \end{aligned}$$

By Assumption 1, $(\pi_r - \pi_t) > 1$. Note that $1 - \pi_r(1-\pi_r) = \pi_r^2 + \pi_r(1-\pi_r) + (1-\pi_r)^2$. Because of this equality, we can show that the LHS is smaller than the first term on the RHS, that is

$$(1-\pi_r)\pi_r^2 + \pi_r^3(1-\pi_r) + (1-\pi_r)^2\pi_r^2 < 2\pi_r\ (1-\pi_r)(1-\pi_r(1-\pi_r))$$

leading to a contradiction; the researcher sends paper C to a regular journal conditional on going into period 3 with zero publications.

To see this more clearly, we need

$$\pi_r^2 + \pi_r^3 + (1-\pi_r)\pi_r^2 < 2\pi_r\ (\pi_r^2 + \pi_r(1-\pi_r) + (1-\pi_r)^2\ )$$
$$\pi_r^2 + \pi_r^3 + (1-\pi_r)\pi_r^2 < 2\pi_r^3 + 2\pi_r^2(1-\pi_r) + 2\pi_r\ (1-\pi_r)^2$$
$$0 < \pi_r^3 + \pi_r^2(2(1-\pi_r) - 1 - 1 + \pi_r) + 2\pi_r\ (1-\pi_r)^2$$
$$0 < \pi_r^3 - \pi_r^3 + 2\pi_r\ (1-\pi_r)^2$$
$$0 < 2\pi_r\ (1-\pi_r)^2$$

which is true. This means $Prob(tenure|s_C(0) = R) > Prob(tenure|s_C(0) = T)$ and hence the researcher submits their three papers to a regular journal in period 3 after having faced rejections only in previous periods.