Degree Inflation: Why Do More College Graduates Pursue a Master's Degree in Taiwan?

Shi-Shu Peng, Chung-Cheng Lin, and Hsiao-Pei Lin*

Abstract

Over the last two decades, an increasingly rising trend is observed among Taiwanese college graduates pursuing a master's degree. We interpret this trend by using a simple static model, which takes the view that college graduates are pursuing better salaries and indicates that the key lies in surging number of college graduates in this period that creates fiercer competition in the college-level labor market and hence depressing college-level salaries. To earn a better salary, more college graduates therefore choose to enter master's programs after graduation, thus creating the growth in those pursuing this higher-level degree. In addition, we take into account human capital investment and consider the dynamics of the model so as to enrich its explanatory ability.

Keywords: Master's Degree, Degree Inflation, Entrance Examination

JEL Classification: I2, I23, I28, J31

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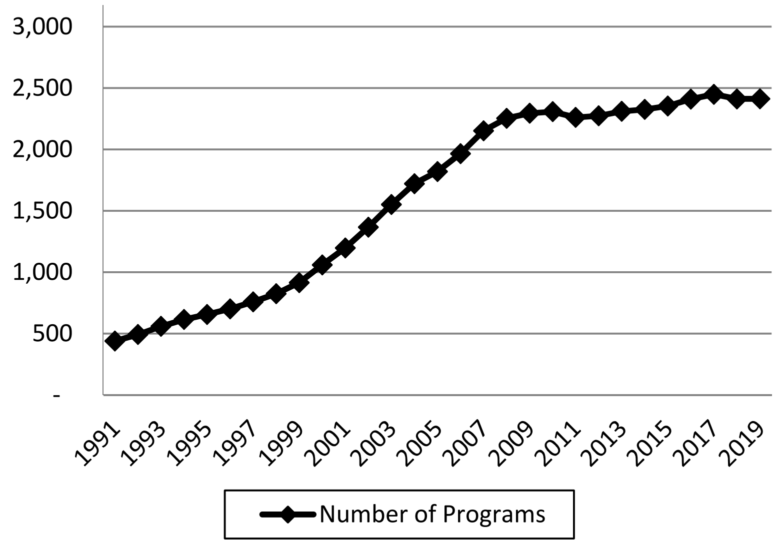
1. Introduction

The last two decades has witnessed a high-growth expansion both in the numbers of master's programs and students in Taiwan, shown in both Figure 1 and Figure 2. Figure 1 first shows the number of master's programs that grows 5.48 times from 440 to 2,412 during the period of 1991 to 2019. Figure 2 then shows the trends of the number of students admitted into and graduated from master's programs during the same period. The number of admitted students grew by 4.4 times from 10,524 to 46,273 (1991 to 2019), while the master's graduates grew by 7.06 times from 7,688 to 54,248 (1991 to 2018).



Source: The Ministry of Education, Taiwan.

Figure 1 Numbers of Taiwanese Master's Programs (1991 to 2019)

In our experience in teaching and interacting with Taiwanese college students on campus, especially junior and senior ones planning for their future career after graduation, we often get their strong feedback that they need to pursue a master's degree; otherwise they won't be able to find good jobs or jobs with satisfactory salaries. Together with the above strikingly high-growth trend in master's programs and students, this feedback motivates us to explain such trend with a model taking the view of college graduates in pursuing better salaries.

Before 1990s, the strict college admission quota in terms of the number of universities and colleges in Taiwan made it extremely difficult for the senior high school students to pursue a bachelor's degree.[1] The annual Joint College Entrance Examination thus became a nightmare for students planning to get into college. In 1994, the Ministry of Education of Taiwan initiated the so-called "educational reform", in which one of the main policies is to broadly set up universities and colleges, causing their number to grow from 50 to 140 during the period of 1991 to 2019. This policy also has strongly raised the number of college graduates by 4.21 times from 54,375 to 229,133 in the 1991 to 2018 period, as shown in Figure 2.

The increasingly intense competition in the college-level labor market caused by the fast expanding number of college graduates during this period is accompanied with the increasing gap between the college-level and master-level returns after the higher education expansion. To show this, Table 1 lists the college-level and master-level starting salaries of Taiwanese college and master's graduates during the period of 1992 to 2019. We can see that from 1999 to 2019, the average starting college-level salaries have fallen from New Taiwan Dollar (NTD) 30,957 to 27,219; while the average master-level starting salaries have fallen from NTD 34,255 to 31,676. The magnitude of the former decrease is about 1.45 times of that of the latter.[2] The higher decrease

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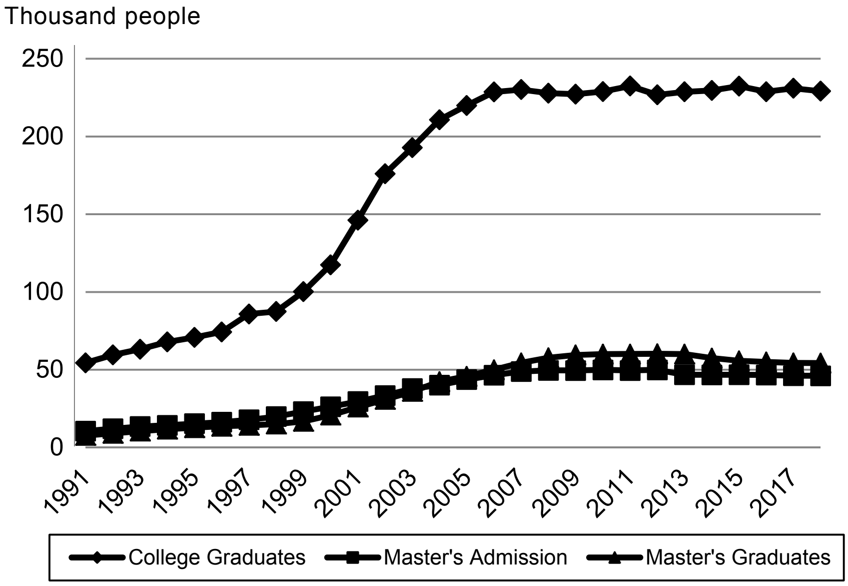
1 According to the Ministry of Education of Taiwan, before 1990s, only about 30% of the senior high school graduates were able to go to college. After the expansion of higher education, about 60% of them went to college in the later 1990s. Nowadays, almost 100% of them go to college.

2 We can also find similar expanding gap between the college- and master-level returns, using the (average and medium) disposable income data in the Report on the Survey of Family Income & Expenditure (1993 to 2019) conducted by the Directorate-

in the college-level starting salaries compared with the master-level ones is hence likely to motivate the college graduates to follow another life plan to create advantages relative to their potential competitors in searching for a job when graduating. Pursuing a master's degree, as one important channel to improve their competitiveness in job searching, thus is likely to partly cause increasingly more college graduates to consider entering master's programs after graduation.



Source: The Ministry of Education, Taiwan.

Figure 2 Numbers of Taiwanese College Graduates, Master's Admitted Students and Master's Graduates (1991 to 2019)

General of Budget, Accounting and Statistics of Taiwan. For instance, the average master-level disposable income is higher than that of college-level by 14% in 1993, 15% to 25% in 1990s, 30% in 2003, 40% in 2004, 50% in 2011, and 50% to 60% till now. We thank one anonymous referee for suggesting this similar trend using an alternative dataset.

Table 1 The Starting Salaries of College and Master's Graduates in Taiwan 1992 to 2019

Year	College-level	Master-level	Year	College-level	Master-level
1992	32,474	–	2008	26,965	31,929
1993	30,896	–	2009	26,802	31,962
1994	30,469	–	2010	26,831	32,129
1995	30,594	–	2011	26,577	32,321
1996	30,891	–	2012	26,216	31,040
1997	31,242	–	2013	26,197	31,163
1998	33,748	–	2014	26,155	31,037
1999	30,957	34,255	2015	26,681	31,489
2000	31,191	34,331	2016	26,752	31,697
2003	29,193	31,276	2017	26,900	31,805
2004	29,113	32,237	2018	26,917	31,611
2005	28,052	32,505	2019	27,219	31,676
2006	28,562	33,769			

Source: Survey on Earnings by Occupation, Ministry of Labor, Taiwan.

Note: 1. Monthly wage in NTD adjusted using 2011 Consumer Price Index (CPI);
2. No data is available in the years of 2001, 2002, 2007;
3. There was no separation between the college-level and master-level starting salaries before 1998, so the data of the latter is not available, marked as "–".

In addition to surging growth in the three trends, we can also have a rough observation from Figure 2 that the trend of the number of college graduates rose the earliest, following by that of the number of master's admitted students, then lastly that of the master's graduates. This very likely indicates the sequence or even the causality of these events as follows.[3] The education reform initiated in 1994 caused the surging number of universities and colleges as well as college graduates, causing more stringent competition in the labor market of college and master's graduates newly graduated from school and depressing the average salaries of the college graduates, then causing higher demand or forming a stronger incentive of pursuing a master's

3 Exploring the causality among these events requires more rigorous empirical studies, which is not the purpose of this theoretical paper.

degree, then causing the administration to have more incentive to set up more master's programs and raise the admission quota, then causing more master's graduates pouring into the job market to compete with the college graduates, and so on and so forth.[4]

Pursuing higher education has been studied in the literature for decades, focusing mainly on its causes and effects. Becker (1962) basically views higher education as an investment in human capital, i.e., people invest in their human capital now for higher future earnings. Spence (1973)'s screening theory takes another view of signaling, i.e., people with higher ability will pursue higher level of education as a signal for revealing their ability to potential employers with limited and asymmetric information, although education is assumed to be not able to enhance people's ability. More people pursuing higher education may lead to over-education, one strand of the literature originated by Berg (1970) and Freeman (1975) since 1970s. Among the researchers of this literature, some focus on the measurement of over-education (e.g., Chevalier, 2003), and some focus on the relationship between over-education and earnings (e.g., Dolton and Silles, 2008; Li et al., 2008).

Our study relates more to the "degree inflation", referring to a rising requirement of higher degrees for certain jobs, even when a higher degree is not necessary. In this study, we aim to interpret the increasingly rising trend among Taiwanese college graduates in pursuing a master's degree over the last two decades, using a simple model taking the view of college graduates in pursuing better salaries. Our model attributes such strong and long-lasting trend to the sharply expanding number of college graduates in this period that creates fierce competition and drives down the college-level salaries. More college graduates therefore choose to enter master's programs in order to earn a better salary after graduation, creating this increasingly rising and long-lasting trend in pursuing a master's degree.

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4 It is interesting and might be inspiring to see whether countries with similar economic and cultural background such as Japan and South Korea have similar phenomenon like Taiwan. For the observation in more detail, please see Appendix.

2. The Model Setup

We suppose that there are a number of college graduates with different social prestige in a typical year. For simplicity, the number of graduates is normalized to be 1. A college graduate faces two different life plans: one is to enter the labor market looking for a job, and the other is to take the graduate school entrance examination to gain an opportunity to get a master degree.[5] Compared with a college graduate, a job seeker with a master's degree has a better chance to get a higher salary.

We also assume that the ability of the college graduates educated or trained in universities of different rankings are different. The higher prestige of a university has, the higher the ability of its graduates is supposed to have. The ability of different college graduates is assumed to be characterized by a variable λ. For simplicity, we assume that λ follows the uniform distribution with the domain of (0,1).

We also suppose that the (expected) wage that a graduate of a higher ranking university will be higher if she/he enters the labor market to find a job. A simple setting is to assume that a college graduate with higher (lower) ability of λ gets a higher (lower) wage of $w+\lambda$, where w is the basic (expected) wage or the wage that all college graduates can at least get.[6]

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5 In Taiwan, almost most master's programs hold the graduate school entrance examination to enroll master's students. Only few master's programs enroll students by applications.

6 The payment received by most employees after graduating from college in Taiwan is monthly salaries instead of hour, daily, or weekly wages. In our model, we still use the term "wage" as it is more commonly seen in the literature. Besides, the assumption of the college-level basic expected wage w (and the master-level basic expected wage W later) implicitly embeds the uncertainty facing college graduates in our theoretical model, although one may explicitly assume a certain setting for uncertainty alternatively, which probably will not essentially and qualitatively change the results here. We thank one anonymous referee for pointing this out.

College graduates and master's graduates have to compete with each other when seeking jobs in the workplace. The wage or salary that college graduates will be offered is adversely affected by the number of college graduates, since the more college graduates, the higher the competition in the labor market, and thus the lower the average college-level wage. We hence assume that $w(x)$ and $w_x < 0$, where x denotes the number of college graduates of a typical year, which is exogenously determined by the education authority. As a result, the payoff of a college graduate (a new bachelor) with the ability of λ choosing not to take the entrance examination of master's programs but finding a job immediately after graduating from college can be represented as follows:

$$U^b = w(x) + \lambda; \quad w_x < 0. \tag{1}$$

If a new college graduate chooses to take the entrance exam of master's programs but not to find a job immediately, she/he has to invest some money and non-monetary costs to prepare for the graduate school entrance examination. The total cost of taking the entrance examination of a master's program, C, is assumed to be:

$$C = c_0 + C_1 = c_0 + \frac{c_1}{\lambda}. \tag{2}$$

The parameter c_0 captures the cost that does not vary with the ability of a student, such as the examination registration fee. The cost $C_1 = c_1 / \lambda$ is the cost that varies with a student's ability, and it is reasonable to assume that this cost is negatively related to a student's ability. In other words, this assumption states that college graduates with higher (lower) ability of λ face lower (higher) costs of preparing for the entrance examination of c_1 / λ, since it takes them less (more) time, efforts and tuition fee in the cram schools for getting admission in master's programs.

Given that the number of students attending the graduate school entrance examination is always higher than the admission quota offered by master's programs, not every candidate has a chance of being admitted or matriculated. We therefore assume that the better of a student's ability is, the higher the chance she/he can enter a master's program. For simplicity, the probability of being admitted or matriculated, p, is assumed to be equal to the ability of a student, namely:

$$p = \lambda. \tag{3}$$

The expected wage of a master with the ability of λ is assumed to be $W + \lambda$, where W is the basic (expected) wage or the wage that all master's graduates can at least get. For simplicity, we assume that W does not vary with the number of college graduates of a typical year. As a result, the expected payoff of a college graduate with the ability of λ choosing to take the entrance examination of a master's program can be represented as follows:

$$U^m = \lambda(W + \lambda) + (1 - \lambda)(w(x) + \lambda) - c_0 - \frac{c_1}{\lambda}. \tag{4}$$

3. The Choice of a New Bachelor

A college graduate with the ability of λ will choose to take the entrance examination of a master's program if $U^m \geq U^b$, that is:

$$\lambda(W + \lambda) + (1 - \lambda)(w(x) + \lambda) - c_0 - \frac{c_1}{\lambda} \geq w(x) + \lambda. \tag{5}$$

The left hand side of equation (5) is the expected benefit of pursuing a chance to get a master's degree, while the right hand side is the opportunity cost. This equation implies that a college graduate will take the entrance examination of a master's program if the expected benefit is no less than the opportunity cost. One can obtain the quadratic equation $\left(W - w(x)\right)\lambda^2 - c_0\lambda - c_1 \geq 0$ by simplifying equation (5). The critical college graduate with the ability of $\overline{\lambda}$ who is indifferent between taking and not taking the entrance examination of a master's program can then be solved since $\bar{\lambda}$ should satisfy the following equation:

$$\left(W-w(x)\right)\bar{\lambda}^2-c_0\bar{\lambda}-c_1=0, \tag{6}$$

and thus

$$\bar{\lambda}^L=\frac{c_0-\sqrt{c_0^2+4(W-w(x))c_1}}{2(W-w(x))},\ \bar{\lambda}^H=\frac{c_0+\sqrt{c_0^2+4(W-w(x))c_1}}{2(W-w(x))}, \tag{7}$$

where $\bar{\lambda}^L$ and $\bar{\lambda}^H$ are low and high critical college graduate with the ability of $\bar{\lambda}^L$ and $\bar{\lambda}^H$. Notice that $\sqrt{c_0^2+4(W-w(x))c_1}>0$ since it is reasonable to assume that $W>w(x)$.

We depict the above decision in Figure 3, in which the horizontal axis represents the ability of λ of a college graduate, and the vertical axis represents the expected payoffs of two life plans of a college graduate. The U^m curve shows the net expected benefit of pursuing a master's degree, $U^m=\left(W-w(x)\right)\lambda+\lambda+w(x)-c_0-c_1/\lambda$, which graphically contains two parts depending upon the sign of λ, although we only consider the case when λ is positive. The slope and curvature of U^m (equation (4)) can be solved as follows:

$$U_\lambda^m=W-w(x)+1+\frac{c_1}{\lambda^2}>0, \tag{4a}$$

$$U_{\lambda\lambda}^m=-\frac{2c_1}{\lambda^3}\begin{cases}<0;\text{ if }\lambda>0\\>0;\text{ if }\lambda<0\end{cases}, \tag{4b}$$

indicating that U^m is an upward sloping concave curve when λ is positive, while it is an upward sloping convex curve when λ is negative.

The U^b line shows the benefit of a college graduate getting a job immediately after graduation $U^b=w(x)+\lambda$, which is a straight upward sloping line with the intercept of $w(x)$, since its slope is positive $(U_\lambda^b=1)$ and unchanged $(U_{\lambda\lambda}^b=0)$, as well as $U^b=w(x)+\lambda\rightarrow w(x)$ when $\lambda\rightarrow 0$. Notice that we only consider the case of positive λ as its domain of is (0, 1).

In Figure 3, there are two intersections $\bar{\lambda}^L$ and $\bar{\lambda}^H$ between the U^m curve and U^b line. Since the corresponding $\bar{\lambda}^L$ of the lower intersection is negative, we therefore only need to discuss the higher intersection of $\bar{\lambda}^H$ that locates in the range of λ between 0 and 1. It is clear to see in Figure 3 that for a college graduate with the ability ranging between $\bar{\lambda}^H$ and 1, she/he will choose to pursue a master's degree since $U^m > U^b$; while she/he will not do so if the ability ranges from 0 to $\bar{\lambda}^H$. This suggests that only those college graduates whose ability is good enough will pursue a master's degree in this model setup. The logic of this is twofold by observing another version of the simplified quadratic form of equation (5): $\left(W - w(x)\right)\lambda - c_0 - c_1 / \lambda \geq 0$, which implies the net expected benefit of pursuing a master's degree. On the one hand, the higher ability raises the probability of being

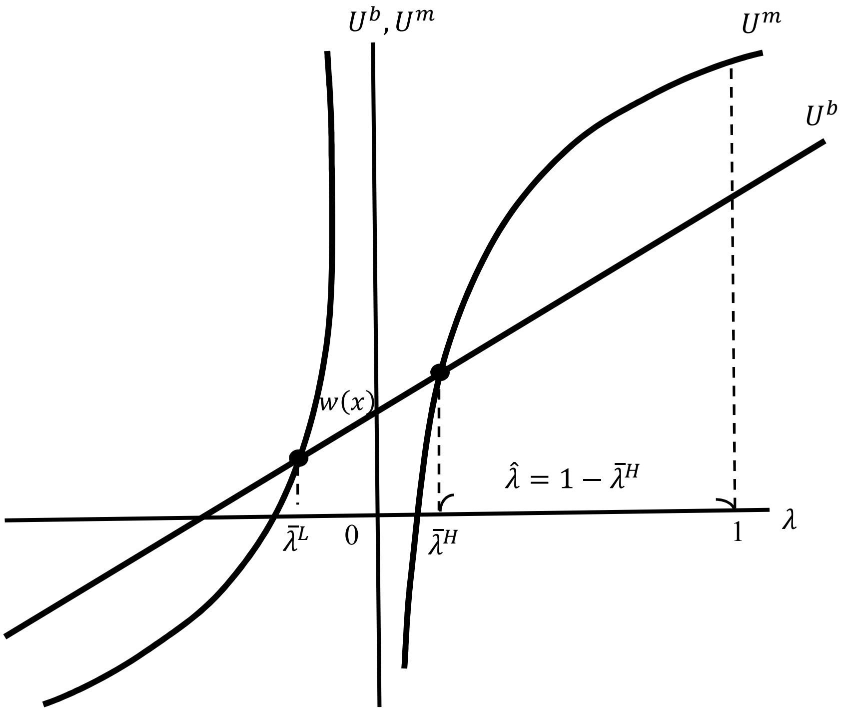

Figure 3 Equilibrium

admitted or matriculated into a master's program, raising the net expected benefit by the magnitude of the increase in ability times the difference between master-level and college-level wage, i.e., $\big(W-w(x)\big)\Delta\lambda$. On the other hand, it raises the net expected benefit by the magnitude of $c_1/\Delta\lambda$ by lowering variable cost of taking the entrance examination of a master's program. Both contributes to the possibility that $U^m > U^b$.

The ratio of college graduates pursuing a master's degree is $\hat{\lambda}=1-\bar{\lambda}^H$, shown as follows:

$$\hat{\lambda}=1-\bar{\lambda}^H=1-\frac{c_0+\sqrt{c_0^2+4(W-w(x))c_1}}{2(W-w(x))}. \tag{8}$$

The ratio of college graduates not pursuing a master's degree is then $1-\hat{\lambda}$, since λ is a variable following uniform distribution between (0, 1). The ratios of $\hat{\lambda}$ and $1-\hat{\lambda}$ can represent the numbers of college graduates who pursue and do not pursue a master's degree, respectively, since we normalize the number of graduates to be 1.

Let us turn to the comparative statics. The rise of the master-level wage W will shift the U^m curve up (since $U_w^m=\lambda>0$) and leave the U^b line unchanged (since U^b is independent with W), enlarging the distance of $\hat{\lambda}$, i.e., the ratio or number of college graduates pursuing a master's degree (higher $\hat{\lambda}$). The rise in the college-level wage $w(x)$ will shift up both the U^m curve (since $U_w^m=1-\lambda>0$) and U^b line (since $U_w^b=1>0$), with the magnitude of the former is only $1-\lambda$ (the probability of not being admitted into a master's program) times of the latter, suggesting an increase of the critical value of $\bar{\lambda}^H$ and a decrease of the distance of $\hat{\lambda}$, i.e., a smaller ratio or number of college graduates pursuing a master's degree (lower $\hat{\lambda}$).[7] The rise of parameters in the fixed costs and variable costs of entering a master's

[7] Put it another way: if one does not take the master's entrance examination, she/he has 100% of chance to get the benefit of increase in the college-level wage $w(x)$; while if one takes the examination, she/he only has $1-\lambda$ of chance to get the benefit of increase in the college-level wage $w(x)$.

program (c_0 and c_1) will both shift the U^m curve down (since $U^m_{c_0} = -1 < 0,\ U^m_{c_1} = -1/\lambda < 0$) and obviously leave the U^b line unchanged, which will increase of the critical value of $\bar{\lambda}^H$ and cause a smaller ratio or number of college graduates pursuing a master's degree (lower $\hat{\lambda}$). Lastly, the rise in the current number of college graduates x will decrease the college-level wage $w(x)$ (since $w_x < 0$). This will shift down both the U^m curve (since $U^m_x = (1-\lambda)w_x < 0$) and U^b line (since $U^b_x = w_x < 0$), with the magnitude of the former is only $1-\lambda$ times of the latter, indicating a decrease of the critical value of $\bar{\lambda}^H$ and an increase of the distance of $\hat{\lambda}$, i.e., a higher ratio or number of college graduates pursuing a master's degree (higher $\hat{\lambda}$).

The comparative statics discussed above are listed as follows:

$$\hat{\lambda}_W = \frac{2(W-w(x))c_1 + c_0\sqrt{c_0^2 + 4(W-w(x))c_1 + c_0^2}}{2(W-w(x))^2\sqrt{c_0^2 + 4(W-w(x))c_1}} > 0\,, \tag{8a}$$

$$\hat{\lambda}_W = -\frac{2(W-w(x))c_1 + c_0\sqrt{c_0^2 + 4(W-w(x))c_1 + c_0^2}}{2(W-w(x))^2\sqrt{c_0^2 + 4(W-w(x))c_1}} < 0\,, \tag{8b}$$

$$\hat{\lambda}_{c_0} = -\frac{\sqrt{c_0^2 + 4(W-w(x))c_1} + c_0}{2(W-w(x))\sqrt{c_0^2 + 4(W-w(x))c_1}} < 0\,, \tag{8c}$$

$$\hat{\lambda}_{c_1} = -\frac{1}{\sqrt{c_0^2 + 4(W-w(x))c_1}} < 0\,, \tag{8d}$$

$$\hat{\lambda}_x = -\frac{2(W-w(x))c_1 + c_0\sqrt{c_0^2 + 4(W-w(x))c_1} + c_0^2}{2(W-w(x))^2\sqrt{c_0^2 + 4(W-w(x))c_1}}\, w_x > 0\,. \tag{8e}$$

In short, equation (8a) states that the higher the master-level wage, the higher ratio or number of college graduates pursuing a master's degree; equation (8b) states that the higher the college-level wage, the lower the ratio or number; equation (8c) and equation (8d) state that the higher the (fixed and variable) costs of pursuing a master's degree, the lower the ratio or number; lastly, equation (8e) states that the more the college graduates, the higher the ratio or number.

4. Why Do More Taiwanese College Graduates Pursue a Master's Degree?

Can we use our simple model to interpret the phenomenon mentioned in introduction section that during the period of 1991 to 2019, the number of enrolled master's students has grown from 10,524 to 46,273 (4.4 times) following the growth of college graduates from 54,375 to 229,133 (4.21 times) stimulated by the education reform in 1994? In other words, can we explain why have a surging number of college graduates pursuing a master's degree over the last two decades?

In our model, five factors affect the trend of college graduates to pursue a master's degree: the master-level wage, the college-level wage, the fixed and variable costs of entering a master's program, and lastly, the number of college graduates. Let us first discuss the first two and the last factors. As shown earlier in section 1, during the period of 1999 to 2019, the college-level salaries have been falling 1.45 times lower relative to the master-level ones.

We can see that from 1999 to 2019, the average college-level salaries have fallen from NTD 30,957 to NTD 27,219; while the average master-level salaries have fallen from NTD 34,255 to NTD 31,676. The magnitude of the former decrease is about 1.45 times of that of the latter. The higher decrease in college-level salaries can surely be explained by various reasons, with a main reason related to the surging number of college graduates, i.e., the last factor above. One can easily find that with the decrease magnitude in the college-level salaries being 1.45 times higher than that of the master-level ones, the ratio or number of college graduates pursuing a master's degree, $\hat{\lambda}$, will increase. This is shown in Figure 4: although the fall in the expected master-level salaries shifts the U^m curve down and decreases $\hat{\lambda}$, the greater fall in the expected college-level salaries caused by the surging number of college graduates shifts down both the U^m curve and U^b line and increases $\hat{\lambda}$, causing a net increase in $\hat{\lambda}$, namely a higher ratio or number of college graduates pursuing a master's degree, since college graduates find that the college-level expected return falls more than the master-level expected return.

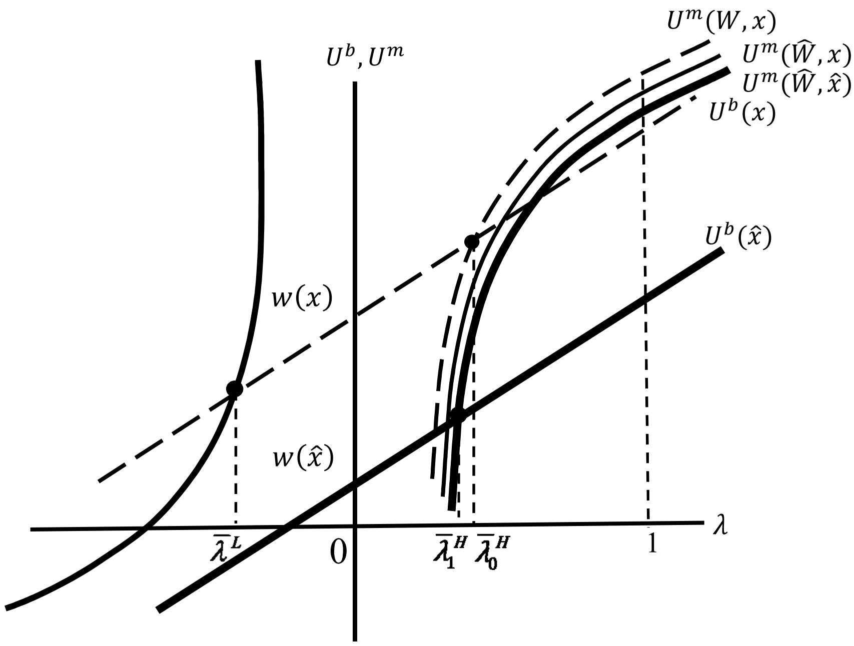

Figure 4 As x Increases, but W Decreases, the Equilibrium $\bar{\lambda}^H$ Decreases, Which Means $\hat{\lambda} = 1 - \bar{\lambda}^H$ Increases.

The other two factors, the fixed and variable costs of entering a master's program, probably do not affect the trend of pursuing a master's degree that much. According to the results of comparative statics i.e., equation (8c) and equation (8d), it should be the decrease in the fixed and variable costs that will cause higher ratio or number of college graduates pursuing a master's degree. Over the last two decades, however, to the best of our knowledge¸ these costs have a trend of slightly increasing instead of decreasing, which may depress instead of stimulate the trend. The observed rising trend in reality therefore indicates that these costs should play a minor role in affecting the trend in pursuing a master's degree.

In summary, we may depict the story as follows: Taiwanese college graduates over the last two decades have faced more severe competition due to rapid growing number of college graduates and thus depressing the college-level salaries in real terms. More college graduates hence choose to enter master's programs in order to earn a better salary after graduation, creating a stronger and long-lasting trend of pursuing a master's degree.

5. Model Extensions

There are two parts in this section. First, we will extend our basic static model into a dynamic model. To do so, one fundamental characteristic is that the equilibrium ratio or number of college graduates pursing a master's degree of the current period t (i.e., $\hat{\lambda}_t$) will be affected by the that of the previous period (i.e., $\hat{\lambda}_{t-1}$). Second, we will incorporate human capital into our basic model. In particular, we will assume that the agent needs to choose his optimal investment of human capital to accomplish the master's degree or improve his productivity for earning higher wage.

5.1 A Dynamic Model

One natural way to introduce this dynamic mechanism is to assume that the probability of being admitted or matriculated (p) in year t is negatively affected by the equilibrium ratio of college graduates pursing a master's degree in year $t-1$. This is because if the equilibrium ratio or number of college graduates pursing a master's degree last year is higher, the college graduates who choose to take the master's entrance exam this year would expect that the ratio or number of college graduates taking this exam will remain higher and thus increase. That is, we assume the probability of being admitted or matriculated, *p*, to be equal to $\rho(\hat{\lambda}_{t-1})$ where $\hat{\lambda}_{t-1}$ is the actual ratio or number of students applying for the master's programs in the previous period, namely:

$$p_t = \rho(\hat{\lambda}_{t-1});\ \rho' < 0. \tag{9}$$

The expected payoff of a college graduate with the ability of λ choosing to take the master's entrance exam (i.e., equation (4) earlier) then becomes:

$$U^m = \rho(\hat{\lambda}_{t-1})(W + \lambda_t) + \left[1 - \rho(\hat{\lambda}_{t-1})\right](w(x) + \lambda_t) - c_0 - \frac{c_1}{\lambda_t}. \tag{10}$$

With this setting, the condition (equation (5) earlier) with which a college graduate with the ability of λ will choose to take the master's entrance exam, i.e., $U^m \geq U^b$, becomes:

$$\rho(\hat{\lambda}_{t-1})(W + \lambda_t) + \left[1 - \rho(\hat{\lambda}_{t-1})\right](w(x) + \lambda_t) - c_0 - \frac{c_1}{\lambda_t} \geq w(x) + \lambda_t, \tag{11}$$

which can be simplified as $[(W - w(x))\rho(\hat{\lambda}_{t-1}) - c_0]\lambda_t - c_1 \geq 0.$ This in turn leads to the critical college graduate with the ability of $\bar{\lambda}_t$ who is indifferent between taking and not taking the master's entrance exam (i.e., equation (7) earlier):

$$\bar{\lambda}_t = \frac{c_1}{\left[W - w(x)\right]\rho(\hat{\lambda}_{t-1}) - c_0}\ . \tag{12}$$

The ratio or number of college graduates pursuing a master's degree in year *t* is:

$$\hat{\lambda}_t = 1 - \bar{\lambda}_t = 1 - \frac{c_1}{\left[W - w(x)\right]\rho(\hat{\lambda}_{t-1}) - c_0}. \tag{13}$$

Simply observing this equation, one can see that under this type of transfer function, the equilibrium ratio or number of college graduates pursuing a master's degree $(\hat{\lambda}_t)$ will evolve following a form of waving shape. That is, a rising $\hat{\lambda}_{t-1}$ will cause $\hat{\lambda}_t$ to fall, while a falling $\hat{\lambda}_{t-1}$ will cause $\hat{\lambda}_t$ to rise.

The comparative statics here are as follows (i.e., equation (8a) through equation (8f) earlier):

$$\frac{\partial\hat{\lambda}_t}{\partial w}=\frac{c_1\rho(\hat{\lambda}_{t-1})}{[(W-w(x))\rho(\hat{\lambda}_{t-1})-c_0]^2}>0, \tag{14a}$$

$$\frac{\partial\hat{\lambda}_t}{\partial w}=-\frac{c_1\rho(\hat{\lambda}_{t-1})}{[(W-w(x))\rho(\hat{\lambda}_{t-1})-c_0]^2}<0, \tag{14b}$$

$$\frac{\partial\hat{\lambda}_t}{\partial c_0}=-\frac{c_1}{[(W-w(x))\rho(\hat{\lambda}_{t-1})-c_0]^2}<0, \tag{14c}$$

$$\frac{\partial\hat{\lambda}_t}{\partial c_1}=-\frac{1}{(W-w(x))\rho(\hat{\lambda}_{t-1})-c_0}<0, \tag{14d}$$

$$\frac{\partial\hat{\lambda}_t}{\partial x}=-\frac{c_1\rho(\hat{\lambda}_{t-1})}{[(W-w(x))\rho(\hat{\lambda}_{t-1})-c_0]^2}w_x>0, \tag{14e}$$

$$\frac{\partial\hat{\lambda}_t}{\partial\hat{\lambda}_{t-1}}=-\frac{c_1(W-w(x))\rho'}{[(W-w(x))\rho(\hat{\lambda}_{t-1})-c_0]^2}<0. \tag{14f}$$

The economic meaning of equation (14a) through equation (14e) is the same as that of equation (8a) through equation (8e), and equation (14f) indicates that an increase in $\hat{\lambda}_{t-1}$ will cause $\hat{\lambda}_t$ to decrease, while a decrease $\hat{\lambda}_{t-1}$ will cause $\hat{\lambda}_t$ to increase.

We further discuss whether there exists a stable dynamic equilibrium solution for $\hat{\lambda}_t$ in its evolution following the transfer function in equation (13) in the long run. For this specific transfer function in which the previous term $\hat{\lambda}_{t-1}$ appears in the denominator, we adopt the way of eigenvalues to solve for the equilibrium $\hat{\lambda}_t$. In short, we first let the equilibrium $\hat{\lambda}_t$ be a fraction (i.e., $\hat{\lambda}_t = x_t / y_t$), and solve the two simultaneous functions constructed by the nominator and denominator that include x_t, x_{t-1}, y_t, and y_{t-1} to obtain the corresponding eigenvalues. The value of the eigenvalues then determines whether the equilibrium $\hat{\lambda}_t$ will converge, circulate, remain unchanged, or diverge in the long run.

We first let $p_t = \rho(\hat{\lambda}_{t-1})$ to be $\rho(\hat{\lambda}_{t-1}) = 1 - \alpha\hat{\lambda}_{t-1}$ where $\alpha \in (0,1)$ for simplicity. Notice that $\rho(\hat{\lambda}_{t-1})$ can be some other form as long as it ranges between 0 and 1. Here we just want to use this one simple example to show how $\hat{\lambda}_t$ will evolve in the long run. The equilibrium $\hat{\lambda}_t$ can thus be written as the following fraction:

$$\hat{\lambda}_t = \frac{x_t}{y_t} = 1 - \frac{c_1}{(W - w(x))(1 - \alpha\hat{\lambda}_{t-1}) - c_0}. \quad (15)$$

With some algebra, it is easy to show that:

$$\hat{\lambda}_t = \frac{x_t}{y_t} = \frac{(W - w(x) - c_0 - c_1)y_{t\text{-}1} - (W - w(x))\alpha x_{t-1}}{(W - w(x) - c_0)y_{t\text{-}1} - (W - w(x))\alpha x_{t-1}}. \quad (16)$$

This gives us the following pair of simultaneous functions:

$$x_t = (W - w(x) - c_0 - c_1)y_{t\text{-}1} - (W - w(x))\alpha x_{t-1}, \quad (17a)$$

$$y_t = (W - w(x) - c_0)y_{t\text{-}1} - (W - w(x))\alpha x_{t-1}, \quad (17b)$$

which in turn can be shown as:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} -(W - w(x)) & (W - w(x) - c_0 - c_1) \\ -(W - w(x))\alpha & (W - w(x) - c_0) \end{bmatrix} \begin{bmatrix} x_{t\text{-}1} \\ y_{t\text{-}1} \end{bmatrix}.$$

The stableness of this dynamic system hence hinges on the eigenvalues of the following equation, assuming that the eigenvalues to be r:

$$\begin{vmatrix} -(W - w(x)) - r & (W - w(x) - c_0 - c_1) \\ -(W - w(x))\alpha & (W - w(x) - c_0) - r \end{vmatrix} = 0.$$

It is easy to find that the eigenvalues are:

$$r = \frac{(-c_0 \pm \sqrt{c_0^2 - 4d})}{2}, \tag{18}$$

where $d \equiv -b(b-c_0)+(b-c_0-c_1)b\alpha$ and $b \equiv W - w(x)$.

The value of the eigenvalues r determines whether the equilibrium $\hat{\lambda}_t$ will converge, circulate, remain unchanged, or diverge in the long run. The rule is: if $-1 < r < 1$, $\hat{\lambda}_t$ will converge; if $r = -1$, $\hat{\lambda}_t$ will circulate between two values; if $r = 1$, $\hat{\lambda}_t$ will always remain unchanged at some fixed level; if $r > 1$ or $r < -1$, $\hat{\lambda}_t$ will diverge. This implies that there exist different possibilities to the equilibrium ratio or number of college graduates pursing a master's degree ($\hat{\lambda}_t$) in the long run, depending on the value of parameters in the dynamic system (including W, $w(x)$, c_0, c_1, and α in our system).

5.2 A Model with Human Capital Investment

In our basic model, we assume the expected wage of a master with the ability of λ is assumed to be $W + \lambda$, and the wage of a college graduate with the ability of λ is assumed to be $w(x) + \lambda$, with $W > w(x)$ being assumed. Notice that we do not claim that a master's graduate receives higher wage than a college graduate does simply because of degree difference (job-signaling) only and without any possibility of ability difference (human capital). However, since we do not assume that it takes the master's program entrants a certain level of investment in human capital (for instance, studying hard in the master's courses), it thus seems to be natural or more appropriate to attribute $W > w(x)$ to degree difference (job-signaling). We therefore extend our basic model by introducing the concept of human capital investment in two ways so that $W > w(x)$ can be attributed to ability difference caused by human capital investment.

The first way is to assume that it takes the human capital investment of k dollars to accomplish the master's degree. The expected benefit of a master graduate with ability of λ then becomes

$W+\lambda-k$ and his expected payoff becomes (i.e., equation (4) earlier):

$$U^m = \lambda(W+\lambda-k)+(1-\lambda)(w(x)+\lambda)-c_0-\frac{c_1}{\lambda}. \tag{19}$$

A college graduate with the ability of λ will choose to take the master's entrance exam if $U^m \geq U^b$, namely (i.e., equation (5) earlier):

$$\lambda(W+\lambda-k)+(1-\lambda)(w(x)+\lambda)-c_0-\frac{c_1}{\lambda} \geq w(x)+\lambda. \tag{20}$$

The ratio or number of college graduates pursuing a master's degree ($\hat{\lambda} = 1-\bar{\lambda}^H$) is hence (i.e., equation (8) earlier):

$$\hat{\lambda} = 1-\bar{\lambda}^H = 1-\frac{c_0+\sqrt{c_0^2+4(W-k-w(x))c_1}}{2(W-k-w(x))}, \tag{21}$$

and the effect of a change in the cost of human capital investment on $\hat{\lambda}$ is:

$$\hat{\lambda}_k = -\frac{2(W-k-w(x))c_1+c_0\sqrt{c_0^2+4(W-k-w(x))c_1}+c_0^2}{2(W-k-w(x))^2\sqrt{c_0^2+4(W-k-w(x))c_1}} < 0, \tag{22}$$

which means that as the human capital investment required to get the same wage rises, the ratio or number of college graduates who are willing to enter the master's programs will fall.

The second way is to adopt a two-stage decision model. In the first stage (i.e., immediately after graduation of college), a college graduate decides whether or not to take the master's entrance exam, and in the second stage (i.e., the time taking courses, studying, and writing master's thesis in the master's program), given that he is admitted into the master's program, he decides how much human capital to invest in order to obtain higher wage.

We adopt the backward induction to solve for this two-stage decision model. Assume that in the second stage, a master student invests h human capital in his learning in the master's program with the cost of $c(h)$, and expects to get the wage of $W(h)$ after graduation. The condition for his optimal human capital investment h^* is then the marginal cost equals the marginal benefit, namely,

$$\frac{\partial c(h)}{\partial h}=\frac{\partial W(h)}{\partial h}. \tag{23}$$

The expected benefit of a master with the ability of λ is then $W(h^*)+\lambda-c(h^*)$.

In the first stage, for a college graduate with the ability of λ, his expected payoff of choosing to take the master's entrance exam becomes:

$$U^m=\lambda(W(h^*)+\lambda-c(h^*))+(1-\lambda)(w(x)+\lambda)-c_0-\frac{c_1}{\lambda}, \tag{24}$$

and he will choose to take the exam if $U^m \geq U^b$, namely,

$$\lambda(W(h^*)+\lambda-c(h^*))+(1-\lambda)(w(x)+\lambda)-c_0-\frac{c_1}{\lambda}\geq w(x)+\lambda. \tag{25}$$

The ratio or number of college graduates pursuing a master's degree $(\hat{\lambda}=1-\bar{\lambda}^H)$ is:

$$\hat{\lambda}=1-\bar{\lambda}^H=1-\frac{c_0+\sqrt{c_0^2+4(w(h^*)-c(h^*)-w(x))c_1}}{2(w(h^*)-c(h^*)-w(x))}, \tag{26}$$

and the effect of a change in the human capital investment on $\hat{\lambda}$ can be solved as:

$$\hat{\lambda}_{h^*}=-\frac{2(W(h^*)-c(h^*)-w(x))c_1+c_0\sqrt{c_0^2+4(W(h^*)-c(h^*)-w(x))c_1}+c_0^2}{2(W-w(x))^2\sqrt{c_0^2+4(W(h^*)-c(h^*)-w(x))c_1}}\left(\frac{\partial c(h^*)}{\partial h^*}-\frac{\partial w(h^*)}{\partial h^*}\right)=0, \tag{27}$$

since $\partial c(h^*)/\partial h^*=\partial W(h^*)/\partial h^*$. This means that given that higher human capital investment increases master-level wage returns, the magnitude of future human capital investment in the master's program does not affect college graduates' willingness to take the master's entrance exam. Hence the equilibrium ratio or number of college graduates pursuing a master's degree ($\hat{\lambda}$) is not affected by the equilibrium human capital investment (h^*). Why? This is because the human capital investment (h) will affect the ratio or number of college graduates pursuing a master's degree ($\hat{\lambda}$) through two channels: the cost of $c(h)$ and the corresponding expected wage $W(h)$. These two channels appear in our system in terms of a pair $W(h^*) - c(h^*)$, and the marginal effect of h^* on each of them is exactly the same $(\partial c(h^*)/\partial h^* = \partial W(h^*)/\partial h^*)$ and thus canceled out.

6. Conclusion

We explain the increasingly rising trend among Taiwanese college graduates in pursuing a master's degree over the last two decades, using a simple model taking the view of college graduates in pursuing a better salary. Our model indicates the key to such strong and long-lasting trend to be the surging number of college graduates stimulated by the education policy in broadly setting up universities and colleges about twenty years onwards, which has created fiercer competition and depressed the college-level salaries. More college graduates hence choose to enter master's programs in order to earn a better starting salary after graduation, creating this stronger and long-lasting trend of pursuing a master's degree.

This phenomenon, usually common in the Confucian, East Asian societies, or some emerging countries may be harmful to the productivity in the country level, since it creates resource misallocation of the education and human capital. Although the core of such phenomenon might have something to do with some cultural characteristics like the diploma doctrine, policy instruments or institutional designs based on the knowledge of economics may be helpful and feasible to adjust the current status toward the relatively more ideal one such as the master's degree market in some western societies.

Appendix

We found that Japan and Korea experienced higher education expansion about a decade earlier than Taiwan, both in the 1980s. Japan's college number rises from 460 in 1985, 507 in 1990, 649 in 2000, to 795 in 2020. The number of college students rises from 1,835,312 in 1980, 2,133,362 in 1990, 2,740,023 in 2000, to 2,916,078 in 2020 (Source: Ministry of Education, Culture, Sports, Science and Technology, Japan, 2020). Korea's college number rises from 85 in 1980, 107 in 1990, 161 in 2000, to 191 in 2019. The number of college students rises from 402,979 in 1980, 1,040,166 in 1990, 1,665,398 in 2000, to 1,988,458 in 2019 (Source: Korean Educational Development Institute, Korea, 2020). However, due to lack of suitable data, we are unable to trace the time trend of the college- and master-level returns and compare it with the trend of higher education expansion in terms of college and college student numbers for both countries. For Japan, the data of the returns (starting salaries) of the two groups are only available after 2005, much later than the beginning of higher education expansion. Even so, we can still see, from the Summary Report of Basic Survey on Wage Structure (starting salary) in 2019 (Source: Ministry of Health, Labour and Welfare, Japan, 2019), that the difference in the average starting salaries is 28,700 yen between the college-level (210,200 yen) and master-level (238,900 yen) ones, with similar growth rates of 0.96% and 0.94%, respectively, in the period of 2015-2019. This structure of difference between the college- and master-level returns basically holds across enterprise sizes and industries. In addition, Morikawa (2015) estimates that the wage premium for postgraduates relative to undergraduates is approximately 30% in 2007. For Korea, no data of labor returns are separated into college and master's (or graduate) levels in any dataset we can find (including Korean government, Korean Educational Development Institute (KEDI), the United Nations, the World Bank, etc.). Nevertheless, we can still find from OECD (2020) that in 2018, the earnings of Korean graduate-level workers are on average 46% higher than those of college-level ones. We greatly thank one anonymous referee for pointing this possibility of cross-country comparison out and kindly offering the related data for both Japan and Korean.

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學歷通膨：為何越來越多台灣的大學畢業生要念碩士班？

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摘　要

過去二十年來，台灣的大學畢業生在畢業後報考碩士班的比例有持續增加的趨勢。在本文中，我們試圖以一個簡單靜態模型來解釋這個趨勢。此模型主要從大學畢業生為了追求進入就業市場後可以有更高薪資的角度切入，指出之所以出現此趨勢的關鍵，在於此時期因廣設大學而急速增加的大學畢業生數量，加劇了大學畢業生這一級別就業市場的競爭，進而壓低此級別就業者的起薪。為了得到更高的薪資，便有更多的大學畢業生選擇在畢業後繼續升學，因此導致了越來越多大學畢業生畢業後報考碩士班的趨勢。最後，我們引進了人力資本投資與考慮模型動態變化作為延伸，以豐富模型的解釋能力。

關鍵詞： 碩士學位、學位通膨、入學考試
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