years ago or more from the survey year, the variable is coded as the survey year minus 10. This top-coding problem should be minimal given the effect should vary little after 9 years since graduation. We include 10 dummy variables for years since graduation excluding 0 as the reference value.

The vector **X** includes various other control variables, such as education, non-farm status, and survey year and month fixed effects. Lastly, U is the error term representing unobservable determinants for marriage.

The above specification assumes that the relative age effect is linear, while those born in January and February have distinct intercepts. The validity of this specification is an empirical question. To address this question, we relax the restriction and estimate the following equation:

$$Married = \gamma_0 + \gamma_1' BirthMonths + \gamma_2' SchCohort + \gamma_3' YrsGrad + \gamma_4' \mathbf{X} + U, \tag{2}$$

where the vector *BirthMonths* is the set of dummies of birth months. There are eleven dummy variables excluding December as the comparison month. The specification does not restrict any functional form on the relative age effect. We can directly test if the coefficients for January and February are significantly different from those for the other months. A validity check is to test if there is no systematic pattern among the other months.

Table 2 presents the OLS estimates for β_1, β_2, and β_3 in Equation (1) and γ_1 in Equation (2). Complete regression results are available from the authors upon request. In all of our regression analyses below, we obtain robust standard errors adjusted by clustering for individual identifiers to reflect the data structure that individuals and households are repeatedly surveyed.[15] The specifications in Columns 1 and 2 exactly correspond to Equations (1) and (2), respectively. The results show that those women born in

[15] Since individual identifiers are not provided, we create them by using household identifiers and household members' birth years. The underlying assumption is that there is no new household member who replaces an old member with the same birth year. Also, although some households can be surveyed over multiple years, household identifiers cannot be linked between different survey years. Unfortunately, there is nothing we can do with this problem. But our results remain quite robust across individual survey years.

January and February are significantly less likely to get married than others within school cohorts. Specifically, those born in February are about 5 percentage points less likely to be married while those born in January are about 3 percentage points less likely to be married. On the other hand, there seems to be no significant relative age effect. In Column 2, we find that those born in October and September are less likely to be married by about 2.8 percentage points. After investigating this, we find that the effects arise only in the 2006 data. In Column 3, we exclude the 2006 data and find that only January and February are significantly negative. We conclude that the lower probabilities in September and October are accidental results. Figure 1 shows unconditional and conditional marriage probability differentials by birth month. December is chosen as the reference month. There are some irregular fluctuations from December to March, but it seems clear that January and, particularly, February are lower than the other months.

To ensure that the marriage probability differentials specific to January and February indeed arise due to the AAR system, we implemented three robustness checks. First, we check the extent to which people misreport their birthday in the lunar calendar without notifying it. Suppose that some of them reported to be born in February or January were actually born in March in the solar calendar. They should enter school one year later because school entrance is determined by their solar-calendar birthday. Then, it is not surprising to find that they are less likely to be married at a given age. This is, however, not a serious problem because we have already controlled for years after graduation as well as education levels. To further investigate the issue, we exploit the fact that in certain years, even the last day in January in the lunar calendar cannot be in March in the solar calendar. For example, March 1st in 1971 in the solar calendar is February 5th in the lunar calendar. In our sample, there are four such years, 1971, 1974, 1976, and 1982, when even the last day in January in the lunar calendar cannot be in March in the solar calendar. In Column 4, we exclude those born in the four years and re-estimate the equation. If our results so far were driven by reporting of the lunar-calendar birthday as if it were the solar-calendar birthday, there should be no significant January effect for those years. On the contrary, we find that those born in January are significantly less likely to be married. In fact, for this sample, we find that the effect is slightly larger for January than for February. Although it is still possible that there are people who report their lunar-calendar birthday without notifying it, we conclude that this should not drive our main results here.

In Column 5, we control for monthly age and its quadratic term instead of the linear relative age effect term. Monthly age is calculated as 12×(survey year) + (survey month) − 12×(birth year) − (birth month), which is one's exact physical age. The results show that the physical age does not matter in determining the timing of marriage after controlling for school age. We still find that, if one was born in January or February, then she is less likely to be married than her school-cohort peers.

In Column 6, we estimate the same specification, Equation (2), for the sample of *men*. As mentioned earlier, there is no reason why the AAR effect exists only among women. However, it seems reasonable to suppose that the cultural age is not as a critical factor for men as it is for women in the marriage market. For example, women are more likely to be pressured to marry by parents than men are. Parents, who are in older generations, are more likely to use the lunar calendar and consider the cultural age for their daughters. Indeed we find that there is no AAR effect among men. Instead, it seems that the relative age effect is more apparent. We find that those born earlier—not just those born in January and February—are more likely to be married than others within school cohorts.[16] Figure 2 shows the marriage probability differentials by birth month for men. Unlike Figure 1 for women, it seems that the marriage probability weakly increases in the relative age, except for March.

III. Asian Age Reckoning prior to Marriage Market

In the previous Section, we found that those women born in February and January are less likely to be married even after controlling for the relative age effect. Before we proceed and exploit the marriage probability differentials to estimate the effect of marriage on labor supply, in this Section, we check one possible case violating the validity assumption for the instrumental variable. Those born in January and

[16] An interesting finding is that the marriage probability gets lower for those born in March (the oldest). Some parents intentionally misreport the birthday of their children actually born in March to January or February in order to get them to start schooling one year earlier, particularly for sons born in March. If this is true, those registered to be born in March are selected on the unobservables. This is interesting, but further investigation on this finding is beyond the scope of this paper.

February might feel inferior and, more importantly, be perceived so by their peers. This might have long-term impacts on personalities and, ultimately, their future labor supply.

Since there is no information about the earlier stage of life for adult women in the KEAPS, we use the data from another national survey, the Korean Education Longitudinal Survey (KELS). The survey includes information for 6,814 7th grade students (3,262 female and 3,552 male students). Most students were born in 1992 or 1993.[17] They are from younger birth cohorts than those in the KEAPS sample where birth year ranges from 1972 to 1983. Thus, although the results in this Section cannot be directly applied to those in the KEAPS sample, we think that the results are still informative.

We investigated various objective and self-reported characteristics but report here only three major variables. The results for other characteristics are qualitatively similar. First, we examine whether academic performance differs by birth month. In particular, it is important to check whether academic performance differs distinctly for those born in January and February. Figure 3 shows average standardized test scores (with mean 50 and standard deviation 10) by birth month on three subjects: Korean, English, and Mathematics, which are high-stake subjects for college admission. We are mainly interested in female students, but we also present the results for male students for the purpose of comparison. Overall we find no distinct difference in average test scores between those born in February and January and others. On the other hand, we find some evidence on the relative age effect in academic performance. The most observable case is Math for male students. The findings here suggest that it is likely that older students accumulate a larger amount of human capital compared to others within school cohorts, while this relative age advantage is more likely to be continuous.

Also, in Figure 4, we check two non-academic characteristics. In the first graph, we look at whether students have served as student government officers. This variable might represent how active or social a student is. We find that students who were born earlier (or are older than their peers) are significantly more likely to have served or to be elected as student government officers. The effect seems to be rather

[17] The results below are qualitatively the same even if we exclude those born before March in 1992 (late school starters) and those born after February in 1993 (early starters).

continuous, and there is no distinct change in February or January. Lastly, we examine whether students are confident in their appearance. Again we find no AAR effect for both male and female students. There is no relative age effect for female students. On the other hand, it seems that there is a weak relative age effect for male students. This is probably because male students' confidence in appearance is more likely to depend on the extent of physical development, such as height and weight, which continuously change by birth month. For female students, the confidence would rather depend on other factors, such as facial attractiveness or body fitness, which do not necessarily change continuously by birth month.

The key conclusion in the Section is that there is no AAR effect in the earlier stage of life. This is not surprising. Figure 5 is the age profile of the marriage probability. The horizontal axis represents physical monthly age, which is defined earlier. The vertical axis is the likelihood of marriage at a given monthly age. We find that the AAR effect on marriage starts to appear after age 28.[18] It is interesting to find that age 28 happens to be the average age at first marriage in 2008.

IV. Effects of Marriage on Labor Supply

In this Section, we estimate the causal effect of marriage on labor supply. We define the following linear probability model of labor supply:

$$Work = \alpha_0 + \alpha_1 Married + \alpha_2' SchAge + \alpha_3 RelAge + \alpha_4' YrsGrad + \alpha_5' \mathbf{X} + V \,, \tag{3}$$

where *Work* is the indicator of whether the woman participates in the labor force. In this paper, we use a narrow definition of LFP. We define that one participates in the labor force if she works for pay during the last week of the survey. We continue to include the three key control variables for the marriage equation, *SchAge*, *RelAge*, and *YrsGrad*. One thing to note here regarding *SchAge* is that it is conventional to use the

[18] In the graph, those born in January and February are *more* likely to be married before around age 26. This might reflect that they could be attractive in the marriage market since they are physically younger than others within school cohorts. Thus, among those born in January and February, those who want to marry earlier could find their spouse more easily. However, the differentials are not statistically significant.

biological age to measure potential labor-market experience in the labor supply equation or the Mincerian wage equation. However, in fact, people have much more in common with others in the same school cohort than with those who were born in the same birth year.[19] We believe that it is more appropriate to control for the school age rather than the physical age.[20]

Also we include *RelAge* to capture, if any, the linear relative age effect. It is likely that the older within a school cohort, the better they perform academically. Even if we control for education levels or years of schooling, it is still possible that the relative age effect remains in terms of, e.g., school quality and, as a result, labor force participation.

As another important control variable, we include the number of years after graduation by including the vector *YrsGrad*. The dummy variables are expected to capture the effects of labor market experience on labor supply. Recall that the variable is top coded. But the problem should not be severe since the labor market experience effect on LFP is likely to be constant after 9 years since graduation, which is reasonable to assume.

The vector **X** includes the same set of individual characteristics we included in the marriage equation. Lastly, *V* is the error term representing unobservable determinants for LFP. We specify that *Married* is endogenous in the sense that marriage and labor supply are interdependent decisions. Preferences for marriage and working outside home are likely to be correlated. To identify the causality, we exploit the marriage probability differentials due to the AAR effect. The key assumption is that the excluded instrumental variables, that is, *Jan* and *Feb*, are uncorrelated with the second-stage equation error term, *V*.

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[19] Both grade repetitions and drop-outs are very rare in Korea. If any, they are more likely to be those who go abroad to study. Drop-out rates are a little bit high for vocational high school students. According to national statistics from the Korea Educational Development Institute, the drop-out rate (including both voluntary and involuntary drop-outs) is 0.8 percent for middle-school students (grades 7-9), 0.8 percent for regular high-school students (grades 10-12), and 2.6 percent for vocational high-school students. The rate is extremely low for elementary-school students mainly because of compulsory schooling.

[20] Vegard Skirbekk, Hans-Peter Kohler, and Alexia Prskawetz (2004) compare the timing of first marriage and childbirth by birth month, particularly for women born in two consecutive months, December and January, in Sweden. Between these two groups of women, there exists the difference of 11 months in the age at leaving school because the Swedish school year runs from January to December. They find that those born just one month later (born in December) marry and have children significantly later compared to those born in January. The findings indicate the importance of school cohort (what they call "social age") rather than "biological age" for one's life experience.

The assumption is likely to be valid given that there is no obvious reason why being born in those two particular months directly and distinctly affects labor supply.

Table 3 presents regression results by different specifications as well as by different estimation methods. For brevity, we present only the effect of marriage (α_1) and the relative age effect (α_3). Complete regression results are available from the authors upon request. Column 1 presents the results when we estimate Equation (3) by OLS. Columns 2 to 5 present 2SLS estimates of different specifications. In Columns 3 and 4, we omit the linear relative age term. In Column 5, as we did with the marriage equation, we control for the physical monthly age and its squared term instead of the relative age term. In Column 4, we estimate the just-identified model by creating one dummy variable for January and February.

The OLS estimate shows that marriage decreases the LFP rate by 39 percentage points. We find no relative age effect on LFP. The 2SLS estimates across different specifications are larger in the absolute terms than the OLS estimates. When we control for the relative age effect in LFP, we find that marriage decreases the LFP rate by 41 percentage points.

Note that we find no significant relative age effect across specifications. This is a bit surprising given our findings in the previous Section that the relative age matters in academic performance as well as other non-academic traits, such as active participation in student government and confidence in appearance. The lack of the relative age effect in labor supply, however, does not completely exclude the possibility that the relative age effect might appear in the labor markets in other forms, such as wage and job characteristics. The 2SLS estimates get larger in the absolute terms when we exclude the relative age from the second stage equation.

Diagnostic tests for 2SLS estimation support the validity of our instrumental variables across different specifications. The F-statistic for the significance of instrumental variables is high enough, particularly when we exclude the relative age term. The F-statistic in the just-identified model is over 38. The null hypothesis of over-identification restriction is not rejected. As a robustness check, we also use the LIML estimator given its relative advantages over 2SLS in the finite sample (Alfonso Flores-Lagunes, 2007; Angrist and Krueger, 2001). The results show that the LIML estimates are not only significant but also a bit larger in the absolute terms than the corresponding 2SLS estimates.[21]

Next, we focus on women aged 28 or older. The rationale for this sample restriction is twofold: First, the effect of marriage on labor supply might be stronger for these women. It is likely to be more costly for them to get pregnant and to nurse babies.[22] Second, in Figure 5, we found that the AAR effect in the marriage probability appears only after around age 28. Since our empirical strategy is to exploit the marriage probability differentials arising due to the AAR system, it might as well make more sense to focus on the age range where the AAR effect plays a significant role in determining marital status.

Table 4 presents regression results across different specifications and estimation methods. The 2SLS estimates say that marriage decreases the LFP rate by about 72 percentage points. The OLS estimates are more significantly biased for older women. The results from the first-stage regression show that the AAR effects are larger for older women. Those born in January and February are about 6 percentage points less likely to be married than others within school cohorts. The LIML estimates are remarkably similar to the 2SLS estimates across different specifications.

Furthermore, we examine older women's labor supply by their education level. Due to the limitation of the sample size, we divide them into two educational groups: high school graduates and 2-year college or 4-year university graduates. Figure 7 presents the monthly age profiles of marriage probability and LFP by education. The top graph is for high-school graduates, and the bottom one for college graduates. The top graph shows that for high-school graduates, the AAR effect exists after around age 27, while it seems to diminish in age. On the contrary, below age 26, it seems that those born in January and February are *more* likely to be married. The gap is, however, statistically insignificant after controlling for our control variables. On the other hand, among college graduates, the AAR effect starts to be pronounced since age 29. The size of the effect seems to be smaller than that among high-school graduates.

[21] For just-identified models, 2SLS and LIML are identical (Roberto S. Mariano and James B. McDonald, 1979).
[22] In the sample of older women,

The bottom graph shows the age profile of LFP by education. It shows that for high-school graduates, those women born in January and February are more likely to work for pay since around age 28, which is about one year later that the age when the AAR effect starts to appear. The gap in LFP also seems to disappear at age 30. For college graduates, it appears that those women born in January and February are more likely to work since age 29, which almost exactly corresponds to the age the marriage probability gets differentiated by birth month.[23]

Tables 5 and 6 present regression results. We use the same specifications as those in Table 4. For the sample of high school graduates, *YrsGrad* cannot be included because all except extremely late school starters (about 6 percent) should graduate more than 9 years ago when they are 28 years old or older. The results in Table 5 are remarkably similar to those in Table 4 for all women. The first-stage results show that the AAR effect is larger in the absolute terms for high-school graduates, which is expected from Figure 7.A. The F-statistic for joint significance of instrumental variables is less than 10 when we include the relative age term or month age terms. But it becomes over 10 in Column 3 and over 25 in the just-identified model in Column 4. The null of over-identifying restrictions is rejected across specifications. Table 6 presents the results for college graduates. The second-stage regression results are also very similar to those in Table 4 or in Table 5. In this sub-sample, F statistic for the significance of instrumental variables is below 10. It is not surprising given Figure 7.A where the marriage probability differentials do not look large enough. However, the LIML estimates are almost same as the 2SLS estimates.

V. Conclusion

The findings of this paper indicate that marriage significantly depresses young women's labor supply in Korea. The OLS estimates are biased toward zero, suggesting positive selection into marriage. There are mainly two potential explanations, which are complementary. The first (supply side) explanation is that women drop out of the labor force in order to specialize in home production. This is plausible particularly given that Korean parents have strong preferences for their children's education and the

[23] The age range is extended to 18-36 in Figure 8.

returns to investment in children are quite high. The second (demand side) explanation is the labor market discrimination against married women. Discrimination may take different forms. For example, it is said that when coworkers are married, one of them should quit the job. In this case, the woman is more likely to quit. Also, the parental leave system is not well utilized, although it exists officially. Many married women quit voluntarily anticipating that they cannot continue their job when they are pregnant. Lastly, discrimination might exist within households. Husbands or their parents who prefer the traditional family type might discourage wives' labor market activities. They might believe that marriage is more stable when wives specialize in housework and husbands focus on paid work.

Positive selection into marriage is in contrast with the finding from the U.S. (Van Der Klaauw, 1996). Our finding implies that the unobservable characteristics that improve women's opportunities in the labor market also make them more attractive in the marriage market. There are many possible explanations for this finding. It might be because women's general ability is better compensated within households or because men with higher ability tend to prefer women with higher ability as their spouse. More in-depth studies are warranted.

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Table 1. Individual Characteristics by Birth Month

Birth Month	College	Non-farm	Married	LFP	N
January	0.587	0.956	0.473	0.613	20,628
	(0.492)	(0.206)	(0.499)	(0.487)	
February	0.592	0.951	0.442	0.646	20,218
	(0.491)	(0.216)	(0.497)	(0.478)	
March	0.576	0.968	0.528	0.584	20,366
	(0.494)	(0.176)	(0.499)	(0.493)	
April	0.599	0.971	0.549	0.573	18,856
	(0.490)	(0.169)	(0.498)	(0.495)	
May	0.592	0.962	0.522	0.592	19,643
	(0.492)	(0.192)	(0.500)	(0.492)	
June	0.585	0.959	0.521	0.606	17,107
	(0.493)	(0.198)	(0.500)	(0.489)	
July	0.571	0.964	0.521	0.597	17,743
	(0.495)	(0.185)	(0.500)	(0.490)	
August	0.587	0.973	0.515	0.591	17,671
	(0.492)	(0.161)	(0.500)	(0.492)	
September	0.579	0.971	0.501	0.602	18,240
	(0.494)	(0.166)	(0.500)	(0.490)	
October	0.634	0.963	0.484	0.620	19,720
	(0.482)	(0.188)	(0.500)	(0.485)	
November	0.623	0.971	0.541	0.600	19,214
	(0.485)	(0.168)	(0.498)	(0.490)	
December	0.601	0.968	0.516	0.598	20,545
	(0.490)	(0.176)	(0.500)	(0.490)	
All	0.594	0.965	0.509	0.602	229,951
	(0.491)	(0.185)	(0.500)	(0.489)	
Chi-squared Test	0.338	0.287	15.14***	5.373**	
[p-value]	[0.561]	[0.593]	[0.000]	[0.020]	
Wald Estimate				-0.534***	
				[0.000]	

Notes: Sample means are presented. Standard deviations are in parentheses. College is the indicator of whether the person graduated from a 2-year college or 4-year university. Non-farm is the indicator of whether the main income source of her household is not farming. Married is the indicator of whether she is married. LFP is the indicator of whether she works for pay. Chi-squared Test is to test for whether E(X = 1 | January or February) = E(X = 1 | March to December). The test statistic is adjusted by clustering for individual identifier (computed by using **clchi2** in Stata). The p-value is presented in brackets. ***Statistically significant at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Table 2. Regression Results for Marriage Probability Equation: OLS

	(1)	(2)	(3)	(4)	(5)	(6)
February	-0.051***	-0.062***	-0.063***	-0.088***	-0.050***	-0.012
	(0.012)	(0.013)	(0.015)	(0.027)	(0.012)	(0.014)
January	-0.029**	-0.039***	-0.037**	-0.093***	-0.028**	0.006
	(0.011)	(0.013)	(0.015)	(0.025)	(0.011)	(0.014)
Relative Age	0.001			0.002		
	(0.001)			(0.002)		
Monthly Age					0.082	
					(0.067)	
Monthly Age Squared					-0.001	
					(0.001)	
November		0.017	0.020			0.006
		(0.013)	(0.015)			(0.014)
October		-0.028**	-0.022			0.026*
		(0.013)	(0.015)			(0.014)
September		-0.027**	-0.018			0.018
		(0.013)	(0.015)			(0.015)
August		-0.017	-0.017			0.049***
		(0.014)	(0.015)			(0.015)
July		-0.004	-0.002			0.038***
		(0.013)	(0.015)			(0.015)
June		0.006	0.009			0.031**
		(0.013)	(0.015)			(0.015)
May		0.006	0.013			0.036**
		(0.013)	(0.015)			(0.015)
April		0.011	0.017			0.038***
		(0.013)	(0.015)			(0.014)
March		-0.007	-0.009			0.008
		(0.013)	(0.015)			(0.014)
Observations	229,951	229,951	186,246	59,575	229,951	177,382
Adjusted R-squared	0.259	0.260	0.258	0.221	0.259	0.148

Notes: Columns are separate regressions. All regression include common control variables: school age, 2-year college, 4-year university, dummies for years after graduation, non-farm, dummies for survey years, and dummies for survey months. Robust standard errors, adjusted by clustering for individual identifier, are presented in parentheses. Columns 1, 2, and 5 include all women in the final sample. Column 3 excludes year 2006. Column 4 restricts the sample to those who were born in 1971, 1974, 1976 and 1982 when January in the lunar calendar is not March in the solar year. Column 6 includes all men in the final sample. ***Statistically significant at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.

Figure 1. Marriage Probability Differentials: Women

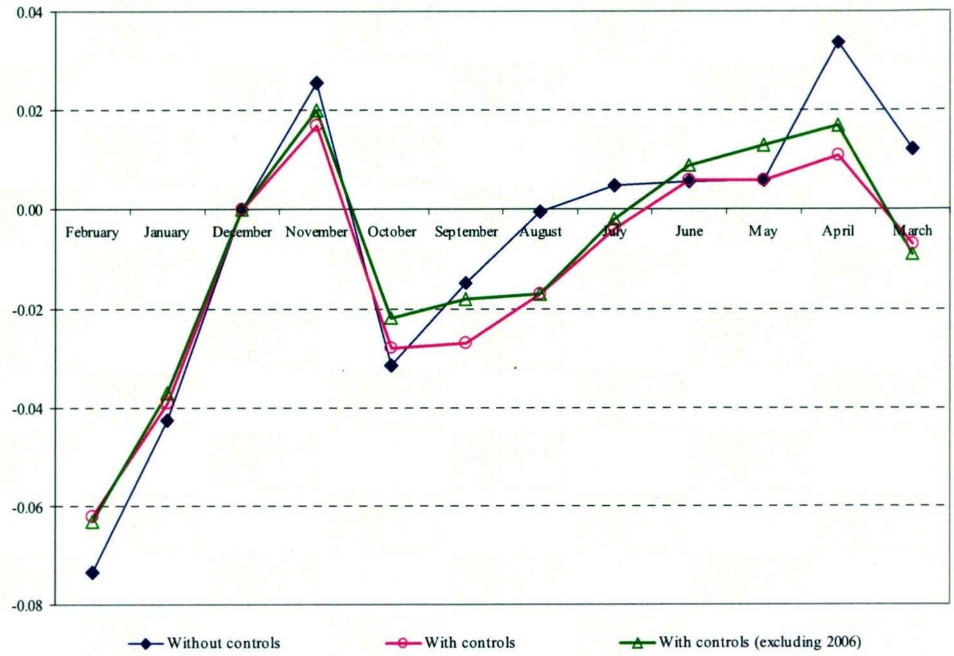
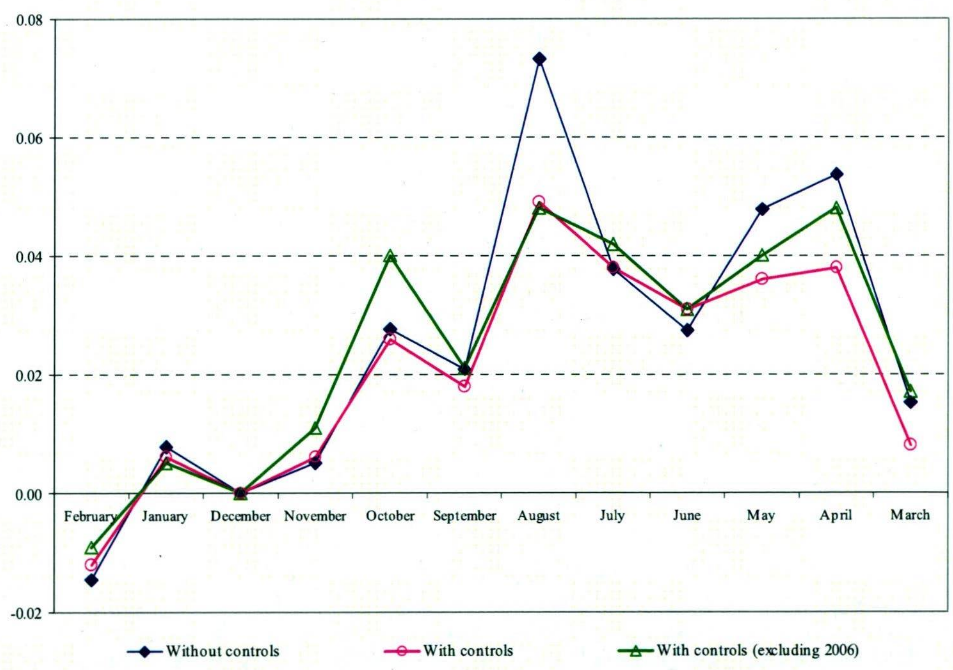
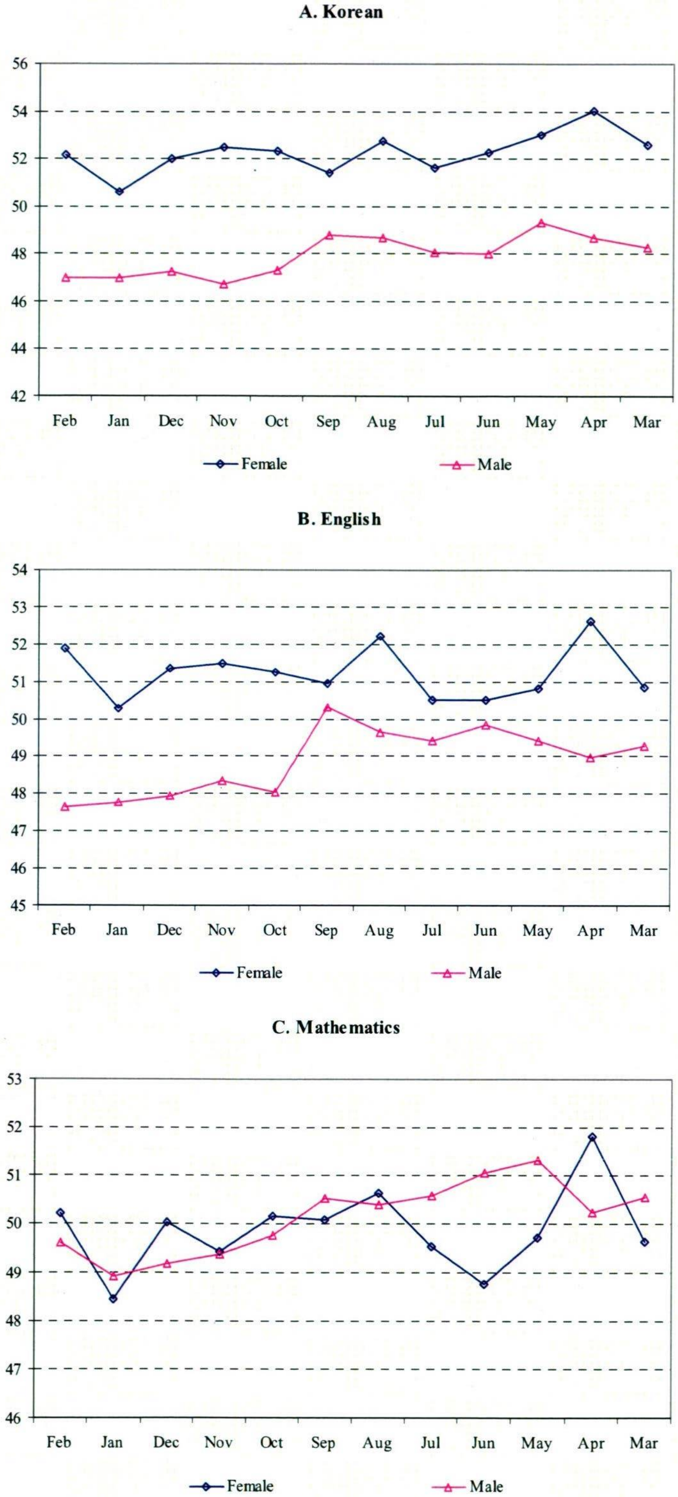


Figure 2. Marriage Probability Differentials: Men



Notes: The estimates used for this graph are calculated from Table 1 (blue line with squares) and taken from Column 2 in Table 2 (red line with circles) and from Column 3 in Table 2 (green line with triangles). December is the reference month (= 0). For Men, the estimates used for this graph are calculated using the sample of men in the same way as did the authors for Figure 1.

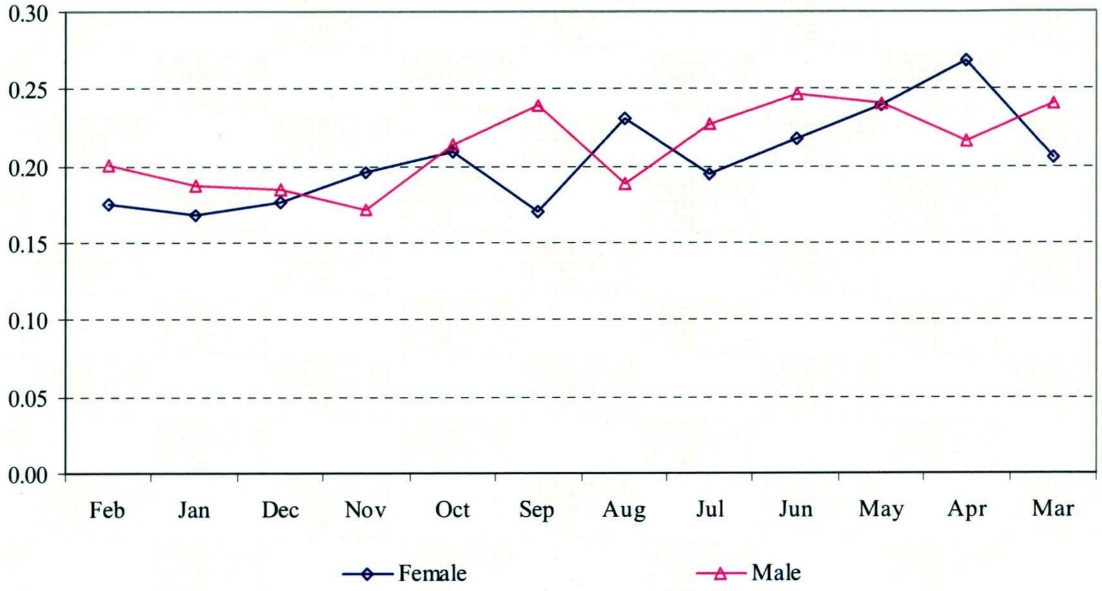
Figure 3. Standardized Test Score



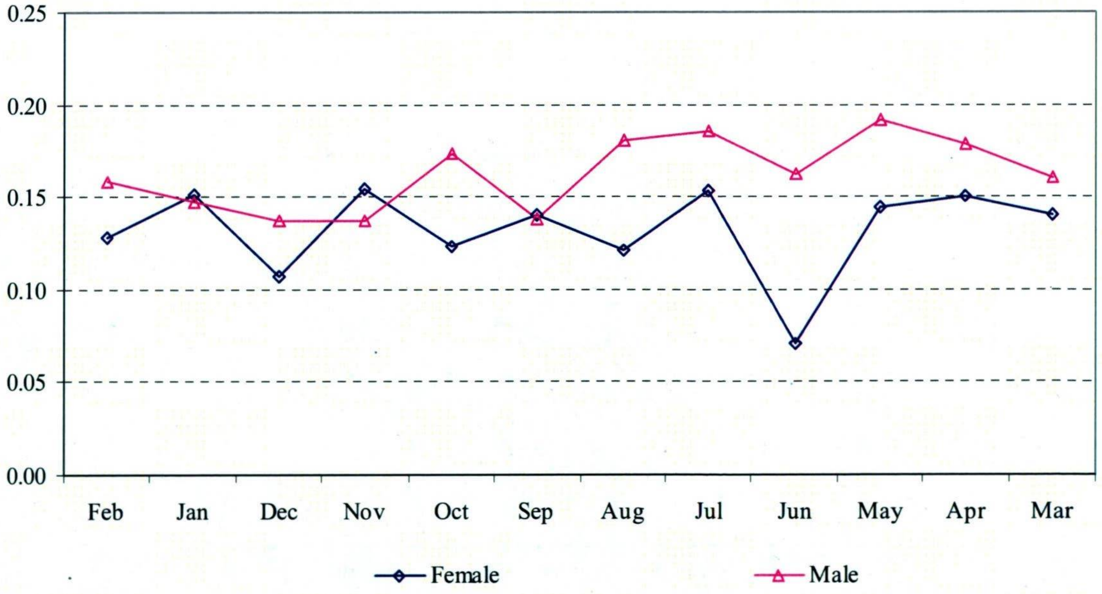
Notes: Korean Education Longitudinal Study, 2005. All respondents are 7th grade students. Test scores are standardized with mean 50 and standard deviation 10. For females, N = 3,220 for Korean, 3,249 for English, and 3,223 for Mathematics. For males, N = 3,501 for Korean, 3,540 for English, and 3,498 for Mathematics.

Figure 4. Student Government Officers and Confidence in Appearance

A. Student Government Officers

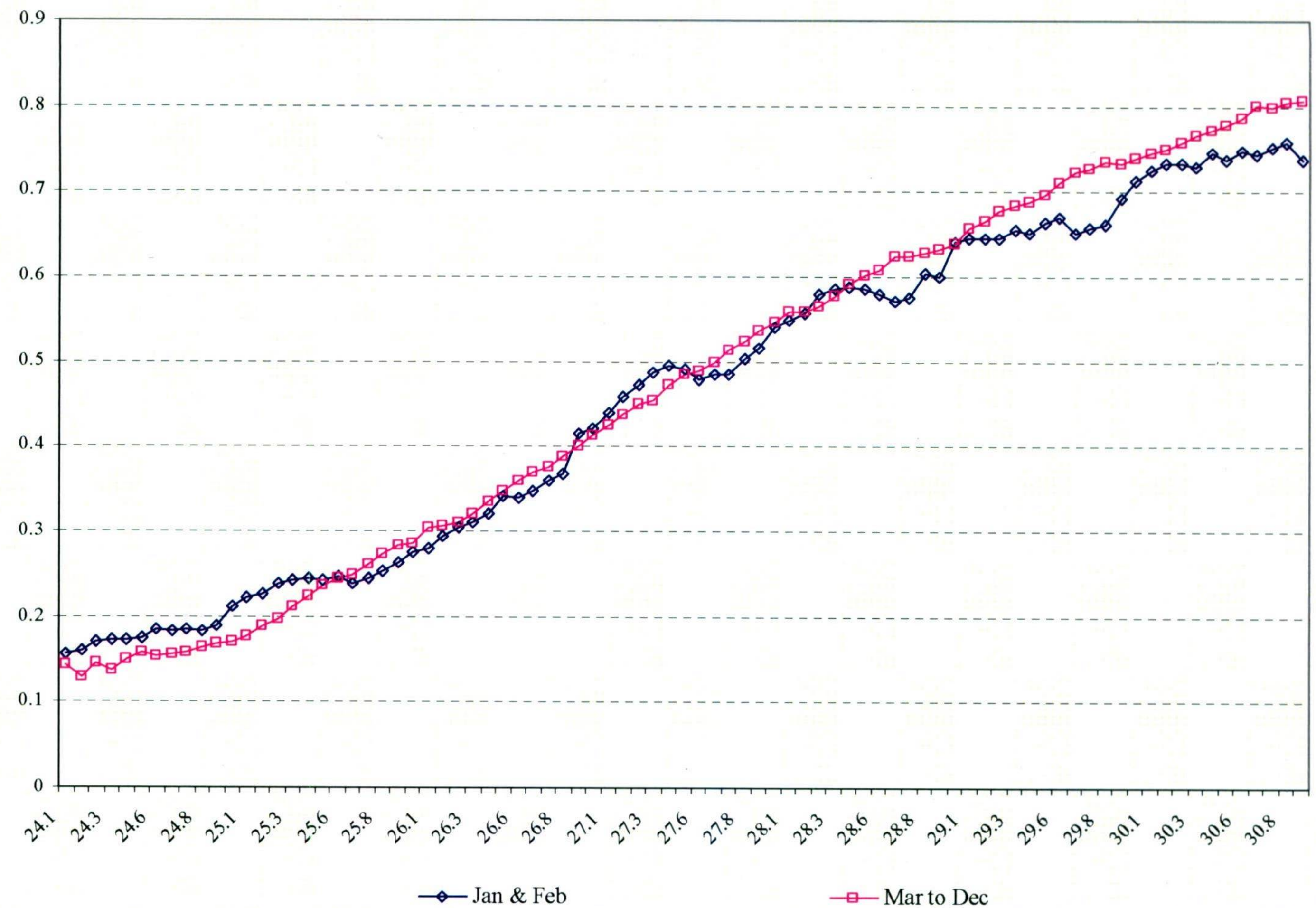


B. Confidence in Appearance



Source: Korean Education Longitudinal Study, 2005

Figure 5. Monthly Age Profile of Marriage Probability by Birth Month



Note: Monthly Age = (Survey Year)*12 + Survey Month – (Birth Year)*12 – Birth Month.

Figure 6. Monthly Age Profile of Labor Force Participation by Birth Month

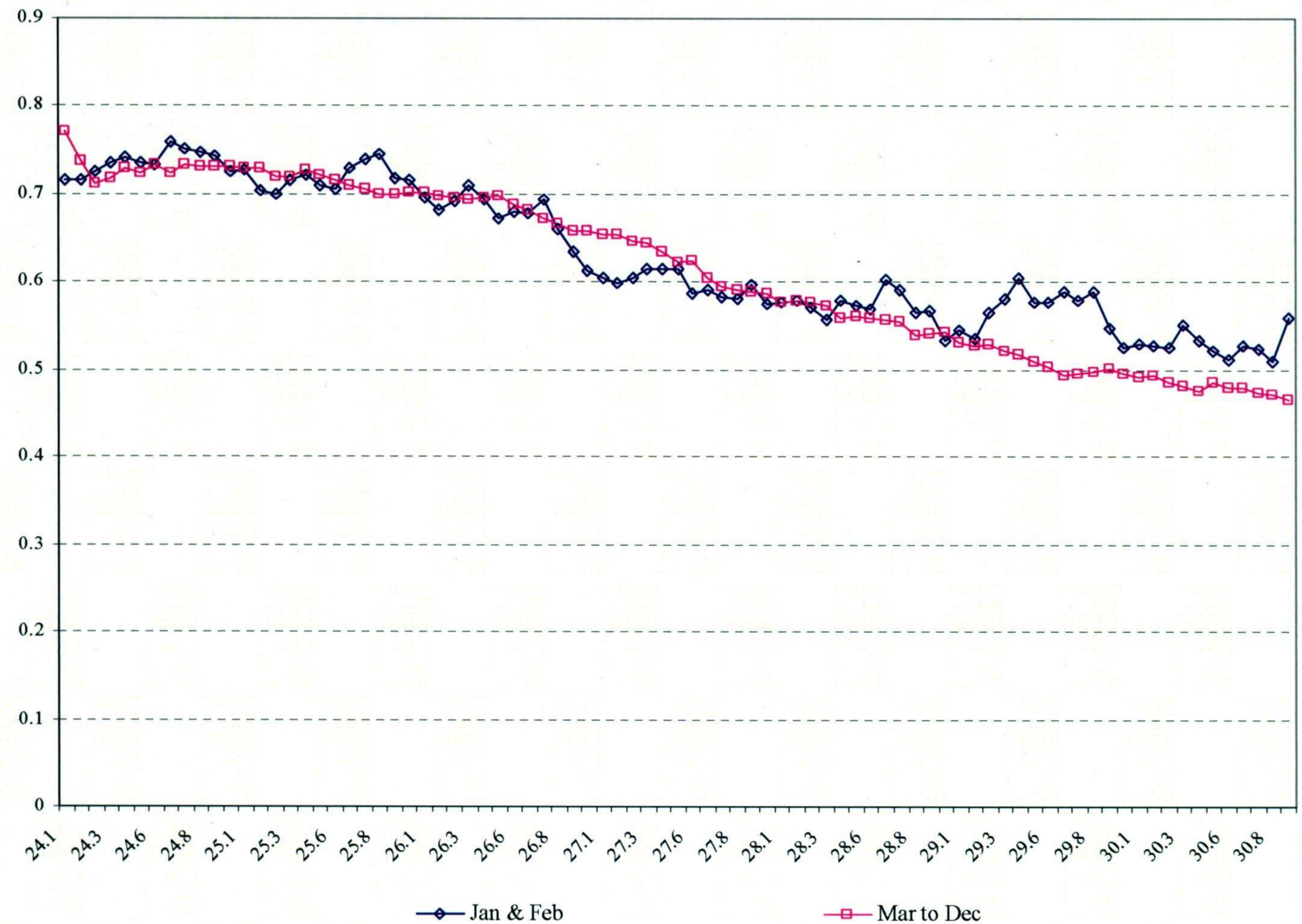


Table 3. Regression Results for Labor Force Participation Equation

	(1) OLS	(2) IV	(3) IV	(4) IV	(5) IV
Second Stage					
Married	-0.394***	-0.409**	-0.540***	-0.491***	-0.406**
	(0.006)	(0.205)	(0.138)	(0.143)	(0.206)
Relative Age	-0.001	-0.001			
	(0.001)	(0.001)			
Monthly Age					-0.046
					(0.071)
Monthly Age Squared					0.001
					(0.001)
First Stage: IVs					
January		-0.029**	-0.034***		-0.028**
		(0.011)	(0.010)		(0.011)
February		-0.051***	-0.057***		-0.051***
		(0.012)	(0.010)		(0.012)
January or February				-0.046***	
				(0.007)	
F statistic		9.68	21.02	38.61	9.50
Hansen J statistic		2.15	1.57		2.16
[p-value]		[0.14]	[0.21]		[0.14]
LIML		-0.411*	-0.545***		-0.407*
		(0.224)	(0.142)		(0.226)
Observations	229,951	229,951	229,951	229,951	229,951
Adjusted R-squared	0.190	0.190	0.174	0.183	0.190

Notes: The dependent variable is LFP. Columns represent separate regressions. Robust standard errors, adjusted by clustering for individual identifier, are presented in parentheses. LIML represents the limited information maximum likelihood estimator. ***Statistically significant at the 1 percent level, ** at the 5 percent level, and * at the 10 percent level.