The gender income gap and the influence of family formation reconsidered

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26 June 2012

The gender income gap and the influence of family formation reconsidered. A methodological comment on Bobbitt-Zeher (2007)*

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Working Paper
26 June 2012

Word Count: 1,919 words (main text), 199 words (references), 3 tables

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Abstract

In her recent study Bobbitt-Zeher (2007) takes on the important task of identifying the contribution of educational factors relative to non-educational factors in the making of the gender income gap among the college-educated and finds that "*family formation has virtually no effect on the income gap*" (Ibid.:13). In this methodological comment we argue that she was led to this conclusion prematurely because her analysis falls short in several respects. We explicate the problems, delineate alternatives and replicate her analysis with similar German data. We find that each of the shortcomings leads to negative bias concerning the influence of family formation. Our results show that family formation is likely to be the single most important factor in the explanation of the income gap.

1. Introduction

The gender income gap remains both a salient social problem and a puzzle to social scientists as it persists even though the number of women in college now exceeds that of men and egalitarian gender norms have been increasingly institutionalized in education and the labor market. In her recent study, Bobbitt-Zeher (2007) takes on the important task of identifying the contribution of educational factors relative to non-educational factors in the making of the gender income gap among the college-educated. Research on the motherhood penalty (Waldfogel 1997; Budig and England 2001; Gangl and Ziefle 2009) suggests that the strongly gendered effect of family formation accounts for a substantial part of the gender gap in pay. Bobbitt-Zeher, however, finds that "*family formation has virtually no effect on the income gap*" (Bobbitt-Zeher 2007:13) and hence ranks family formation among the very least important influences (Ibid.:14). She arrives at this conclusion after an analysis with regression and decomposition methods. In this comment we argue that the neglect of interaction effects, her failure to recognize hours worked as an intervening variable and her decision to restrict the sample to persons in full-time employment invalidate this conclusion.

Our comment is organized as follows: First, we summarize Bobbitt-Zeher's argument regarding the hypothesized influence of family formation. Then, we describe how she aims to test the motherhood penalty hypothesis and the shortcomings of her approach. We also delineate what we believe to be a more adequate use of her methods for the question at hand. We use similar data from the German HIS Graduate Panel (N=4147) to illustrate how the analysis we propose leads to results at odds with Bobbitt-Zeher's: Our results show that family formation is the most important factor to explain the gender income gap among college graduates and even outranks education.

2. Nested Regressions

"*How much do education-related factors -particularly field of study and standardized test scores- contribute to gender disparities in earnings early in young workers' careers, relative to family, work, and aspiration influences?*" (Ibid.:6)

First, the author analyses this question through a series of nested regression models (Ibid.:13), scrutinizing the change of the slope coefficient for *female* as new variable groups are successively added to the model. β_{female} diminishes if at least one added variable a) has a positive effect on income *and* the mean value for that variable is lower for women than for men (mediation) or b) has a negative effect on incomes *and* the mean value for that variable is higher for women than for men (mediation) or c) has an effect on income that is different for women than for men in strength or direction (moderation). Mediation is captured when adding the variable itself to the model, moderation is captured if the model additionally includes a variable which interacts that variable with gender.

The author's theoretical argument suggests that gender *moderates* the effect of family formation, which results in a gender wage (and hence income) gap: "*There is a 7 percent wage penalty for each child that a young woman has. […] The same patterns do not hold for men; fathers experience no comparable wage penalty for their parental status. Furthermore, married men receive higher pay than do unmarried men, while there is some evidence of a wage disadvantage for married women.*" (Ibid.:4) This reasoning would suggest a model that includes the main variable along with an interaction term (as model 5b). The author's model, however does not include any interaction terms (as model 5a) and therefore does not correspond to her theoretical reasoning. Without interaction terms, the model identifies influences on the gender gap through mediation only. Consequently, the very marginal change in β_{female} between

models 4 and 5 in Bobbitt-Zeher's analysis merely identifies how much of the gender gap is due to the fact that women and men differ in the *frequency* of family formation.

Model 5a: $Income = \beta_0 + \beta_1\, female + \ldots + \beta_k\, parenthood + e$

Model 5b: $Income = \beta_0 + \beta_1\, female + \ldots + \beta_k\, parenthood + \beta_{k+1}\, female \times parenthood + e$

Based on similar data from Germany, table 1 illustrates how the inclusion of an interaction term alters the results. Models 5a and 5b are identical except for the interaction term *female*×*parenthood*. Background, values, education and work are operationalized similarly to Bobbitt-Zeher's study.

[Table 1 about here]

The results based on Models 1,2,3,4, 5a, and 6 closely replicate Bobbitt-Zeher's with our data (Table 1) when we apply the same sample restriction (*hours worked per week* ≥35): *Percentage of Gap Explained* increases by a mere 0.7 percentage points when *family formation* is controlled for, whereas *education* increases it by 33.9 percentage points and *work* by 34.1 percentage points. In sum, the inclusion of the respective variable groups reduces β_{female} by margins very similar to those in the original study. The picture changes considerably when we consider the change from model 4 to model 5b instead: In the sample including only the full-time employed *Percentage of Gap Explained* increases by 16.4 percentage points when controlling for *family formation*. The inclusion of the variable group *work* now increases *percentage explained* by only 18.4 percentage points. The value for *education* remains unchanged due to its position in the sequence of variable groups.

3. Decomposition

Second, Bobbitt-Zeher decomposes differences between women and men to identify the influence of educational factors relative to family formation and other factors. Unfortunately, her decomposition analysis too neglects the gender-mediation in the process of family formation that her theoretical reasoning emphasizes. The so called Blinder-Oaxaca-Decomposition allows for a decomposition of a group difference in wages or incomes into up to four components: membership, coefficients, endowments and an interaction between coefficients and endowments (Jones and Kelley 1984).[1]

$$I_A - I_B = (\beta_{0A} - \beta_{0B}) + \sum_{j=1}^{k} \overline{X}_{jB}(\beta_{jA} - \beta_{jB}) + \sum_{j=1}^{k} (\overline{X}_{jA} - \overline{X}_{jB})(\beta_{jA} - \beta_{jB})$$

$$+ \sum_{j=1}^{k} \overline{X}_{jB}(\beta_{jA} - \beta_{jB})$$

$$= \quad \text{membership} + \text{coefficients} + \text{interaction} + \text{endowments}$$

$$= \quad \text{‘unexplained’} \quad + \quad \text{‘explained’}$$

The membership, coefficients and interaction components are often summarized into a single ‘unexplained’ or ‘discriminatory’ component. In the resulting two-fold decomposition the endowments component is usually referred to as the ‘explained’ or ‘non-discriminatory’ and the other components taken together as the ‘unexplained’ or ‘discriminatory’ component (Jones and Kelley 1984; Jann 2008). This summary of the membership, interaction and coefficients components is warranted if and only if there

[1] The ‘interaction component’ refers to an interaction between differences in endowments and differences in coefficients. It is not to be confused with the interaction effects discussed above which refer to differences in coefficients alone and are thus referred to as part of the ‘coefficients component’ in the decomposition.

[2] The question whether to analyze the income or wage gap is a related question that I choose not to

are no theoretical grounds to interpret *any* of the endowments effects as discrimination *and* the interpretation of *all* coefficients, interaction and membership effects as discrimination is indeed theoretically justified. These conditions usually hold in the decomposition's most common application where human capital theory is tested against discrimination theory and wages are regressed on productivity-related characteristics. They do not hold in Bobbit-Zeher's analysis, however, because the coefficients effects for the family formation variables do have a theoretically distinct interpretation (see above). The theoretical argument suggests an attribution of the coefficients effects of the variables *marriage status* and *single-parent status* to the influence of family formation. However, because the author applies a two-fold decomposition, they are misattributed to the *total unexplained* component. The very low *Percentage of Total Gap Explained* for *family formation* (0.1) thus refers to the endowment effect only: a higher or lower incidence of marriage and single-parent status among women. It does *not* refer to the gender-specific consequences of family formation which the motherhood-penalty literature emphasizes. Identification of the coefficients effect as suggested by theory necessitates a more detailed decomposition.

A second problem arises from Bobbitt-Zeher's partial misattribution of the endowments effect for *hours worked*.[2] In her theory section, she argues that *hours worked* intervene between motherhood and income: "*The impact of family formation on gender differences in earnings appears to operate through women's decreased labor force participation. Both length of job experience and part-time employment contribute to lower earnings.*" (Bobbitt-Zeher 2007:5) Hence, to the degree that the gender difference in labor force participation reflects a difference between mothers and fathers, the

[2] The question whether to analyze the income or wage gap is a related question that I choose not to discuss here. See Morgan and Arthur (2005) instead.

endowment effect for *hours worked* should be attributed to the variable group *family formation*.[3] Instead, the author attributes it entirely to the variable group *work related*, thereby further underestimating the influence of family formation.

Again, the original results can be closely replicated with our data when applying the same sample restriction and attribution decisions (see table 2). *Percentage explained* is even slightly negative for the endowment effect of *family formation*, ranking it among the least important factors, as in Bobbitt-Zeher's analysis. The coefficients effect for *family formation*, however, explains € 849.30 or 9.4 percent of the income gap. This figure, however, still is an underestimation. We arrive at the true figure when adding the amount of *hours worked per week*'s endowment effect that is due to motherhood. The total difference in endowments with *hours worked* is 1.98 for the restricted sample. It is 1.66 when comparing childless women and men only (see table 3.1). Under the assumption that the entire difference is due to the effect of parenthood, we estimate that 16.16% (=1-(1.66/1.98) of the endowment effect for *hours worked* should be attributed to *percentage explained* of family formation, i.e. € 128.21. The total amount for *family formation* then is €849.30 + €128.21 = €977.51 or 10.8%, ranking it only behind *industry* and *college major*. The figure is slightly less (€909.30 or 10.0%) when estimating the size of the intervention through *hours worked* more conservatively with a decomposition that is based on regressions without controls for *hours worked* (results not shown).

[Table 2 about here]

[3] The attribution problem for intervening variables is not limited to family formation and work. Some part of the large endowments effect for *occupation* and *industry* are likely to be the direct consequence of horizontal gender segregation into different fields of study. I do not discuss these issues in more detail, to limit my discussion to the relative influence of family formation.

4. Sample Restriction

Above, I argued that the author's neglect of interaction effects in the model specification and the misattribution of *hours worked* as an intervening effect invalidate the author's conclusions concerning family formation. Furthermore, her analysis underestimates any such effects due to a restriction of the sample to persons in full-employment. The issue is separate from those already discussed. As mentioned above, Bobbitt-Zeher points to mothers' decreased labor market participation as the mechanism that intervenes between family formation and women's incomes (Ibid.) If motherhood indeed causes low working hours, then two problems arise from the author's decision to restrict the sample to persons in full-time employment. First, mothers are disproportionately dropped from the sample and the estimated frequency of motherhood is thus negatively biased. Second, those mothers who remain in the sample represent a select group of women who have managed to evade the very mechanism the author points out in her theoretical discussion and seeks to quantify. The estimated effect size of motherhood is thus negatively biased, too. Negative bias in either frequency or effect size of motherhood results in a negative bias of the estimated influence of family formation.

Mothers are indeed disproportionately dropped when the sample is restricted to persons in full time employment and hence the frequency of motherhood underestimated: In our sample the proportion of mothers among all full-time employed is 8.7%, but 64.8% among the part-time employed. Tables 3.1 and 3.2 show that the suggested association between motherhood and working hours is much weaker in the restricted sample than in the sample that includes part-time workers. Mothers work 3.1 hours per week shorter than fathers in the restricted sample but 11.2 hours shorter in the less restricted sample.

[Tables 3.1 and 3.2 about here]

As we expect, some of the findings regarding the relative influence of education and family formation are altered significantly when we apply the methods outlined above to the less restricted sample. In the series of nested regressions *Percentage of Gap Explained* increases by 26.3 percentage points between models 4 and 5b, which is more than by the inclusion of work related factors and only slightly less than by the inclusion of education related factors.

The decomposition results (Table 2) show the amount explained by the coefficient effect for *family formation* increasing to €1,224.3 or 10.6%. The full amount explained by family formation now is €2603.6 or 22.6%.[4] The estimate with the more conservative method is € 2444.71 or 21.2% of the income gap. Either way, when attribution is guided by theory and decisions concerning sample restriction taken accordingly, *family formation* proves to be the single most important influence in the analysis.

5. Conclusion

Bobbitt-Zeher (2007) was led to a premature conclusion because her analysis fell short in several respects. First, in the series of nested regressions, her model lacks interaction terms to account for the disparate effect that family formation has for women and men. Second, in the decomposition analysis she fails to correctly attribute the coefficients effect of family formation because she applies a two-fold decomposition where a more detailed decomposition would have been needed. Third, she fails to recognize hours worked as a variable that intervenes between motherhood and income and thus fails to

[4] $2603.6 = 1224.3 + \left(1 - \left(\frac{2.34}{5.13}\right)\right) \times 2536.1$

adequately attribute the effects. Fourth, she restricts her sample to full-time employed persons, which is theoretically unjustified.

We have replicated her procedure with similar German data, successively correcting the shortcomings of her analysis. We found that each of the shortcomings of Bobbitt-Zeher's analysis leads to negative bias concerning the influence of family formation. Contrary to Bobbitt-Zeher's conclusion that family formation has "*virtually no effect on the income gap*", we found evidence that family formation is the single most important factor in the explanation of the income gap that divides young college educated men and women and it is very likely to be among the very most important factors in the U.S., too. Key parts of our criticisms extend to Marini and Fan (1997) and Leuze and Strauss (2009).

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Table 1: Coefficients for *female* from nested regression models.

		Sample restricted to full-time employed (hrs. worked per week≥35)		Sample restricted to full-time and part-time employed (hrs. worked per week≥15)	
Model number	Model description	Income gap (β_{female})	Percentage of gap explained	Income gap (β_{female})	Percentage of gap explained
1	Female	-9,057	-	-11,541	-
2	Female and background	-9,250	-2.1%	-11,683	-1.2%
3	Female, background, and values	-8,461	6.6%	-10,687	7.4%
4	Female, background, values, and education	-5,393	40.5%	-7,331	36.5%
5a	Female, background, values, education, and family formation (without interaction term)	-5,328	41.2%	-7,457	35.4%
5b	Female, background, values, education, and family formation (with interaction term)	-3,905	56.9%	-4,298	62.8%
6	Female, background, values, education, family formation (with interaction term), and work	-2,234	75.3%	-2,280	80.2%

Source: HIS Graduate Panel 1997. Notes: Estimates from WLS regressions, *background* are controls for parental educational and economic status. *Values* are measured by the aim *earning very well*. *Education* factors are the percentage female of the subject of the field of study, High-School-Leaving-Certificate scores (Abitur), College Degree scores, highest degree earned, and whether degree granting institution is university or polytechnic. *Family formation* is a parenthood-dummy only, the interaction term is *parenthood*female*. *Work* factors are number of hours worked per week, industry, sector, position, function and firm-size.

Table 2: Oaxaca-Blinder-Decomposition

	Sample restricted to full-time employed (hrs. worked per week≥35)				Sample restricted to full-time and part-time employed (hrs. worked per week≥15)			
	Amount Explained (€)	p-Value	Percentage of Total Gap Explained	Rank of Influence	Amount Explained (€)	p-Value	Percentage of Total Gap Explained	Rank of Influence
Endowments Effects								
Background	-80,50	(0.265)	-0,9	11	-67,25	(0.296)	-0,6	11
Importance of Having Lots of Money	338,60	(0.000)	3,7	7	389,80	(0.000)	3,4	7
Education Related								
Scores	-80,72	(0.119)	-0,9	12	-38,99	(0.349)	-0,3	10
Percentage female of college major	1547,10	(0.000)	17,1	2	1599,70	(0.000)	13,9	3
Institutional Selectivity	-254,40	(0.008)	-2,8	13	-223,30	(0.008)	-1,9	12
Doctoral vs. Graduate Degree	73,54	(0.183)	0,8	8	80,66	(0.100)	0,7	8
Family Formation	-37,07	(0.591)	-0,4	9	-19,04	(0.310)	-0,2	9
Hours worked per week	793,40	(0.000)	8,8	5	2536,10	(0.000)	22,0	1
Work Related								
Function	-59,95	(0.850)	-0,7	10	-1004,00	(0.997)	-8,7	13
Industry	1767,10	(0.000)	19,5	1	1668,70	(0.000)	14,5	2
Sector	619,00	(0.008)	6,8	6	654,10	(0.003)	5,7	6
Other work factors	905,10	(0.000)	10,0	3	991,70	(0.000)	8,6	5
Coefficients Effect of Family Formation	849,30	(0.011)	9,4	4	1224,30	(0.001)	10,6	4
(All other coefficients effects and shift effect)	(2674,90)	(-)	(29,5)	(-)	(2745,30)	(-)	(23,8)	(-)
Men's Income	47335,00	(0.000)			46807,80	(0.000)		
Women's Income	38278,50	(0.000)			35267,00	(0.000)		
Total Income Gap	9056,50	(0.000)	(100)		11540,80	(0.000)	(100)	
N	3808				4147			

Source: HIS Graduate Panel 1997. Notes: Estimates from WLS regressions, two-sided test, women's and men's coefficients at equal weight (.5), interaction component therefore cancelled out.

Table 3.1: Hours worked per week by gender and parenthood status (mean values, full-time employed only)

	With children	Without children	Total sample
Male	47.82	47.76	47.78
Female	44.72	46.10	45.80
Difference	3.10	1.66	1.98

Table 3.1: Hours worked per week by gender and parenthood status (mean values, full-time and part-time employed)

	With children	Without children	Total sample
Male	47.33	47.25	47.27
Female	36.09	44.91	42.14
Difference	11.24	2.34	5.13

Source: HIS Graduate Panel 1997. Note: Weighted estimates, full-time employed: Persons with at least 35 hours worked per week. Part-time employed: Persons with at least 15 and less than 35 hours worked per week.