Online Appendix I: A Model of Household Bargaining with Violence

In this appendix I develop a simple model of household bargaining that incorporates violence and shows under what assumptions an increase in women's relative income leads to a decline in violence.

Let $U_w (C_w, S)$ be a woman's utility which is increasing in her own consumption (C_w) and increasing in safety (S) and let $U_m (C_m, V)$ be a man's utility which is increasing in his own consumption (C_w) and in violence (V). Assume that there is an upper bound to violence (death) $\overline{V}$ and $S = \overline{V} - V$. Both utility functions are assumed to be strictly concave, monotonically increasing, differentiable and homothetic. I is total household income and α is the share of income a woman would get if she were not in the partnership (not necessarily what she earns inside the relationship). To focus on partnerships that will experience some violence, assume that the marginal rate of substitution between consumption and violence is greater for women than men where V=0 ($MRS_m ((1- \alpha)I, 0) < MRS_w (\alpha I, \overline{V}))$. We denote as T the set of feasible utility pairs (U_m, U_w) that the partners may obtain if they reach an agreement and the utility each gets from dissolution of the partnership (the disagreement payoff or single state utility) as $(d_m, d_w) = (Um((1-\alpha)I, 0), Uw (\alpha I, \overline{V}))$.

I first show that the domestic violence problem constitutes a Nash bargaining problem and that a Nash bargaining solution provides a unique solution to the problem.

Lemma 1: Under the above assumptions, the problem is a Nash bargaining problem with a Nash bargaining solution (Nash, 1950).

Proof:

The following necessary and sufficient conditions are met:

1) The set T is compact. This is satisfied since the set of feasible allocations is compact and U_m and U_w are continuous.

2) The set T is convex. This is satisfied since the set of feasible allocations is convex and U_m and U_w are continuous.

3) $d= (U_m((1- \alpha)I, 0), U_w (\alpha I, \overline{V}))$ is a member of T.

4) For some member (U_m, U_w) of T it is the case that $U_m>d_m$ and $U_w>d_w$. This holds under the assumption that $MRS_m ((1- \alpha)I, 0) < MRS_w (\alpha I, \overline{V})$. ■

To allow for different degrees of bargaining power between partners, we will use Kalai's asymmetric Nash bargaining solution. The solution to the asymmetric bargaining problem (U^*_m, U^*_w) maximizes the following expression as shown by Kalai (1983):

$(U_m-d_m)^{\tau} (U_w-d_w)^{1-\tau}$

subject to $(U_m, U_w) \geq (d_m, d_w)$ and (U_m, U_w) feasible, where τ is a measure of bargaining power of the man.

I study next how an increase in the relative wage of women affects utilities of both men and women.

Lemma 2: An increase in α results in an increase in U^*_w and a decrease in U^*_m.

Proof:

Take α and α' such that $\alpha' > \alpha$. Then $d_w(\alpha') > d_w(\alpha)$ and $d_m(\alpha') < d_m(\alpha)$. Therefore,

$$\frac{\tau}{(1-\tau)} \frac{(U_w - d_w(\alpha'))}{(U_m - d_m(\alpha'))} < \frac{\tau}{(1-\tau)} \frac{(U_w - d_w(\alpha))}{(U_m - d_m(\alpha))}$$

and by convexity of T we have that $U^*_w (\alpha') \geq U^*_m (\alpha)$. ■

This alone does not guarantee that an increase in α results in a decline in violence. This depends on the shape of the contract curve.

Lemma 3: the contract curve has a positive slope.

Proof:

Let (C_m, V) and (C_m', V') be points on the contract curve such that $C_m' > C_m$ and $V' < V$.

By definition, $MRS_m(C, V) = MRS_w(C, \overline{V} - V)$ since (C_m, V) is a point on the contract curve. This implies that $\frac{C'_m}{V'} > \frac{C_m}{V}$ and $\frac{C'_w}{\overline{V} - V'} < \frac{C_w}{\overline{V} - V}$

By homotheticity and strict concavity of utility functions, $MRS_m(C'_m, V') < MRS_m(C_m, V)$ and $MRS_w(C'_m, \overline{V} - V') > MRS_w(C_m, V)$. This implies that $MRS_w(C', \overline{V} - V') > MRS_m(C', V')$ and the point ($C'm$, V') cannot be on the contract curve. ■

Theorem 1: An increase in α results in a decrease in violence.

Proof:

Take α and α' such that $\alpha' > \alpha$.

Then $U^*_w(\alpha') > U^*_w(\alpha)$, by lemma 2, which implies that $V(\alpha') < V(\alpha)$, since the contract curve has a positive slope by lemma 3.■

The above simple model of household bargaining shows that under certain reasonable assumptions (namely strict concavity, differentiability and homotheticity of utility functions) an increase in a woman's relative income leads to a decline in violence against her.[1]

[1] Incorporating the marriage market should not affect this comparative static result. Rather, the marriage market simply influences the disagreement payoff (d) which will become the maximum of an individual's single state utility and the expected utility from another match. In this paper I do not focus on the marriage market because there is no data for California on marriages and divorces.

Online Appendix II: Determinants of the Wage Gap

I estimate the impact of changes in underlying composition of the labor force on male and female wages as an additional test of the exogeneity of the wage measures. In columns 1 and 2 of Appendix Table 1 I present estimates of the impact of female college enrollment, immigration, incarceration flows and changes in the female population aged 15-44 on female wages. In column 1 all covariates are entered together and in column 2 I present estimates in which the covariates are entered separately (each row represents a separate regression.) I do the latter because the lack of precision when all covariates are entered together may reflect collinarity. For each specification I also include county and year fixed effects and county and race specific linear time trends and the natural log of the relevant population age 15-44 (these controls are included in the main regression specifications presented in Table 2). In columns 3 and 4 I present the same results for males. It should be noted that these results exclude the lags of domestic violence (hospitalization for assault or arrests for domestic violence) that I include in some of the regressions of the impact of wages on violence which would, if anything, likely further decrease the estimated effects of changes in underlying characteristics of workers on wages.

As is evident from the table, these variables appear to have no significant impact on either female or male wages as constructed according to equation (1). The point estimates are all small and imprecise.

In columns 5-8 I present the same set of estimates but on wages that are constructed based on changes in the underlying industrial structure of the county – not changes in state-wide wages in industries dominant in the county in 1990. While the results are somewhat similar to those in columns 1-4, the point estimates for education (college enrollment) are slightly larger and more precisely estimated for males, though still relatively small and insignificant. This is consistent with the possibility of selective, endogenous, changes in industrial structure over time.

Appendix Table 1: Predicting Wage Changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	female	female	male	male	female	female	male	male
Ln(female college students)	0.01	0.012			0.018	0.018		
	[0.041]	[0.041]			[0.050]	[0.055]		
Ln(male college students)			0.044	0.046			0.063	0.069
			[0.052]	[0.050]			[0.040]	[0.045]
Ln(non-intimate homicides)	-0.005	-0.005	0.003	0.003	0.01	0.01	0.014	0.014
	[0.004]	[0.004]	[0.004]	[0.003]	[0.007]	[0.007]	[0.008]	[0.008]
Ln(immigration)	-0.006	-0.006	-0.007	-0.008	0	0.001	0.001	0
	[0.004]	[0.004]	[0.005]	[0.005]	[0.002]	[0.002]	[0.004]	[0.002]
Incarceration flows per 1000 males	-0.012	-0.01	-0.01	-0.007	-0.035	-0.039	-0.011	-0.026
	[0.012]	[0.011]	[0.013]	[0.011]	[0.027]	[0.031]	[0.020]	[0.027]
Ln(female pop 15-44)	-0.038				-0.052			
	[0.038]				[0.050]			
Ln(male pop 15-44)			-0.036				-0.061	
			[0.048]				[0.044]	
Observations	1144	1144	1144	1144	934	934	934	934
R-squared	0.95		0.89		0.92		0.9	
Robust standard errors in brackets								
Wages used	state	state	state	state	industry	industry	industry	industry
Covariates entered together	Y		Y		Y		Y	
Covariates entered separately - each row a separate regression		Y		Y		Y		Y