FINANCIAL DEVELOPMENT AND CONFLICT MITIGATION: CAN FINANCE COMBAT CONFLICT?

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April 23, 2019

1 A model of impact of credit supply on conflict levels

1.1 Setting

In this section we present a theoretical framework to understand the impact of bank credit supply on conflicts. The framework outlines a general optimization program for a party to a conflict given its expected reward and costs. The framework is parsimonious by design but quite general in sope, and compatible with different types of conflict. At the same time, it incorporates several innovative but realistic features. For example, it incorporates a frequently reported feature of conflict financing, namely that funds obtained for legitimate businesses are diverted to finance conflicts.

There are two sectors in an economy: Industry and Conflict. There are two parties or groups, i and j. Each group is homogeneous. Our parsimonious model incorporates too few group characteristics to allow for heterogeneity among the members of a group. Each group may engage in both sectors. Capital invested in industry and conflict sectors by group i are denoted by K_i^I and K_i^c respectively. The investments by group j are similarly denoted by K_j^I and K_j^c. Group i's output in the industry sector is given by the production function, $f_i(K_i^I)$, where $f_i : [0, \infty) \rightarrow [0, \infty)$ is assumed to be strictly increasing, concave, twice differentiable and Inada condition-satisfying.

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The production function for Group j, $f_j(K_j^I)$, satisfies similar conditions. Per unit price of the industrial output is 1, so f_i or f_j denotes the value of industrial output.

Groups i and j may also engage in conflict with a view to obtaining a reward characterized by a binary distribution; X or 0. We model X such that it fits all types of conflict. X can have many forms; political (administrative control of a geographic area), economic (control over natural resources in an area), ethnic (displacement of another community from an area), or religious (extermination of a religion in an area). We assume that, regardless of the specific form of X in a given situation, possession of X generates a monetary outcome for the reward holder. Without ambiguity we denote the monetary outcome also as X. The production function in the conflict sector is represented by F_i for group i. The output of conflict sector can be interpreted as outcomes that propel group i toward winning the conflict and capturing X, such as destruction of employable resources (manpower, capital stock etc) of group j. $F_i : [0, \infty] \rightarrow [0, \infty]$ is strictly increasing, weakly concave, twice differentiable and Inada condition-satisfying. The production function for group j, F_j, satisfies similar conditions.

For tractability we assume that the groups do not have an initial endowment, though all our results hold if this assumption is relaxed. A financial market exists. Groups i and j can borrow money at an interest rate of r from a bank for industrial activity. The lending institution's objective is to break even on each credit decision. The lender is a passive player in the game between the two parties in the conflict. The lender lends $\overline{K_i^*}$ amount of industrial credit to group i, making sure that her objective to break even is satisfied. Institutional regulations as well as the law of the country prevent the lender from lending directly for investment in the violent conflict sector. However, monitoring by the lender is imperfect. Hence, both groups can divert a part of the total credit, $\overline{K_i^*}$ to conflict without the lender's knowledge. Let K_i^c be the amount diverted to conflict by group i. Therefore, the amount left to be invested in industry by group i is $\overline{K_i^*}$- K_i^c. Since $f_i(K_i^I)$ is concave, $f_i(\overline{K_i^*} - K_i^c)$ is convex in K_i^c.

Conflicts generate two types of costs for the participants. The first type is opportunity costs of loss of industrial output arising from diversion of funds. Conflicts also generate special costs due to their unique nature. A conflict of necessity involves collateral damage in the form of destruction of life and property (beyond what the parties intend to inflict on each other). The costs due to collateral damage are indirect costs as opposed to direct costs of conflict such as costs of troops,

ammunitions etc. paid with diverted funds. The direct costs in our model are represented by the opportunity costs noted above. The indirect costs are experienced not only by the party directly responsible for the collateral damage but also by other parties involved in the conflict (as also the rest of the society). Such costs can be substantial [1]. We assume that the indirect cost function, denoted by $C(K_i^c + K_j^c)$, is strictly increasing in the total amount of capital invested in conflict by both groups. Although collateral damages are an inevitable feature of conflicts, incorporating such costs explicitly is a new contribution to conflict modeling. We assume that the indirect cost function C is convex, that is they increase at an increasing rate.

We assume the following two conditions:

I) The probability with which group i wins the prize X is $\frac{F_i(K_i^c)}{F_i(K_i^c)+F_j(K_j^c)}$. Since F_i is concave by assumption, it is easily seen that the probability of winning the conflict by group i is also concave in K_i^c. Note that this probability decreases in $F_j(K_j^c)$, the level of capital investment in conflict by group j. This condition encapsulates the idea of conflict in our model.

II) $X > f_i(\overline{K}_i^*)$ and $X > f_j\overline{K}_j^*$. The reward from conflict exceeds the maximum industrial output when the entire credit is invested in industry (though the expected value of the reward may fall well short). Hence engagement in conflict is tempting for both groups.

1.2 Equilibrium

As the lender is prevented from lending for conflict sector activities, the lender considers only the borrower's output from industry in her lending decision. The lender chooses $\overline{K}_i^*$ such that $f_i(\overline{K}_i^*) \geq \overline{K}_i^*(1+r)$. This condition ensures that the output from industry is sufficient to cover debt repayment. Similarly, the banker lends $\overline{K}_j^*$ to group j such that the output from industry for group j exceeds $\overline{K}_j^*(1+r)$. In other words, we assume that if the entire funds are invested in industry, the loans can be repaid and the lender's break-even conditions are satisfied.

Group i has the following utility function:

$$U_i(K_i^c, K_j^c) = f_i(\overline{K}_i^* - K_i^c) + \frac{F_i(K_i^c)}{F_i(K_i^c) + F_j(K_j^c)}X - r(\overline{K}_i^*) \tag{1}$$

where U_i is assumed to be concave. However, the indirect cost function must impact group i's

[1] Knight, Loayza, and Villanueva (1996) estimate that civil wars in developing countries result in a 2 percent permanent reduction in GDP just from diversion of resources from productive enterprises without taking into account the direct costs of military operations.

utility negatively.

Group i maximises the following utility function U_i

$$U_i(K_i^c, K_j^c) = f_i(\overline{K}_i^* - K_i^c) + \frac{F_i(K_i^c)}{F_i(K_i^c) + F_j(K_j^c)}X - r(\overline{K}_i^*) - C(K_i^c + K_j^c) \tag{2}$$

Note that U_i reflects both opportunity costs of loss of industrial production due to diversion of K_i^c and the indirect cost of conflict $C(.)$. In equilibrium the marginal costs from the two types of costs combined equal the marginal expected reward from the conflict. If $C(.)$ is convex, then U_i is also concave like U_i, because C enters equation 1 above with a negative sign, and all the other terms are concave from our discussion above.

Since U_i is concave and K_i^c belongs to [0,$\overline{K}_i^*$], an equilibrium exists. Further, the first order condition for the equilibrium outcome K_i^{c*} implies that

$$f_i^{'}(\overline{K_i^*} - K_i^{c*}) + C_{K_i^{c*}}(K_i^{c*} + K_j^c) = \frac{F_i^{'}(K_i^{c*})F_j(K_j^c)}{[F_i(K_i^{c*}) + F_j(K_j^c)]^2}X \tag{3}$$

Note that the left hand side of (2) is increasing in K_i^c whereas the right hand side is decreasing. Hence the equilibrium is unique. The first order condition for group j similarly is

$$f_j^{'}(\overline{K_j^*} - K_j^{c*}) + C_{K_j^{c*}}(K_i^c + K_j^{c*}) = \frac{F_j^{'}(K_j^{c*})F_i(K_i^c)}{[F_i(K_i^c) + F_j(K_j^{c*})]^2}X \tag{4}$$

1.3 Implications

Starting from an equilibrium where the marginal costs from the two types of costs combined equal the marginal expected reward from the conflict, what impact does an infusion of credit supply have on investment in the conflict by the two groups? Two implications follow from the model. Both are testable.

(I): An increase in credit supply reduces investment in conflict by all parties. Hence, conflict declines.

The intuition is straightforward. From equation (2), starting from an equilibrium where the marginal expected reward from the conflict equals the combined marginal costs of opportunity loss from not investing in industry and indirect conflict costs, both costs increase at an increasing rate while the

expected reward increases at a decreasing rate with further investments in conflict. Hence an infusion of credit supply necessitates paring conflict investments to bring the two back in equilibrium.

Proof: To estimate the impact of an increase in credit supply on the equilibrium level of investment in conflict by group i, differentiate equation (2) above with respect to $\overline{K}^*$

$$\frac{dk_i^{c*}}{d\overline{K}^*} = \frac{f_i^{''}(\overline{K}^* - k_i^c)}{f_i^{''}(\overline{K}^* - K_i^c) - C_{K_i^c}^{''} + \frac{XF(K_j^c)[(F(K_i^c)+F(K_j^c))F^{''}(K_i^c)-2[F^{'}(K_i^c)]^2]}{([F(K_i^c)+F(K_j^c)]^3)}} \tag{5}$$

The sign of the denominator in the above expression is negative. It follows from the concavity of U_i. [2] The numerator is positive, given our assumption of strictly concave industrial production function (in K_I^i). Hence, the sign of $\frac{dk_i^c}{d\overline{K}_i^*}$ is negative.

(II): The negative relationship between credit supply and conflict (or lack thereof) in the first implication holds for all types of conflict. This follows from our specification of conflict reward X, and the rest of the framework discussed above, that fits all conflict types.

2 Tables

[2] $\frac{\partial U_i}{\partial K_i^c} < 0$ implies that

$f_i^{''}(\overline{K_i^*} - K_i^c) - C_{K_i^c}^{''}(K_i^c + K_j^c) + \frac{XF(K_j^c)[F(K_i^c)+F_j(K_j^c)F^{''}(K_i^c)-2F^{'}[(K_i^c)^2]]}{[F(K_i^c)+F(K_j^c)]^3} < 0$

Table A1: Summary statistics for types of conflict

	1		2		3		4	
	mean	sd	mean	sd	mean	sd	mean	sd
Conflict(G)	0.77	0.42	0.34	0.48	0.18	0.39	0.08	0.27
Conflict(I)	0.85	0.56	0.40	0.59	0.20	0.44	0.09	0.33
Conflict(F)	2.10	6.13	0.43	1.84	0.21	2.23	0.08	0.77
Icredit	0.78	5.41	0.22	1.06	0.96	15.13	2.34	15.68
Naccounts	8.44	1.46	6.68	1.81	8.54	1.20	8.49	1.61
Mcredit	0.64	7.33	0.04	0.17	0.11	1.21	0.22	1.47
Personal credit	0.24	0.93	0.14	0.41	0.45	4.40	0.97	5.77
Total bank credit	1.46	8.93	0.41	1.49	2.27	30.30	5.32	33.81
Literacy rate	63.22	9.28	74.17	10.54	74.52	11.79	82.39	10.03
Urbanisation	37.45	26.63	17.19	12.19	20.85	15.05	31.56	19.76
Population density	0.535	0.260	0.300	0.249	0.833	2.17	1.066	2.77
NSDP	8.78	8.95	11.34	10.02	10.40	10.35	15.05	15.07
Cexpenditure	2.88	1.88	2.77	2.54	2.35	1.85	3.01	2.83
Inequality	0.43	0.25	0.29	0.26	0.40	0.27	0.45	0.37
Unem(General)	1.33	0.73	1.64	1.44	1.42	1.14	1.77	1.45
Unem(Strict)	1.57	0.79	1.45	1.16	1.29	0.92	1.62	1.17
Forests	7.53	2.34	57.38	20.54	16.75	10.70	17.64	17.27
Observations	2252	2123	7839	4525				

1 in the top row indicates conflicts in Jammu and Kashmir and Punjab. These regions are mostly plagued with separatist insurgency. 2 denotes conflicts in North East where ethnic conflicts are rampant. 3 denotes conflicts in LWE states where Maoist insurgency is widespread. 4 indicates conflicts in the rest of the country

Table A2: Timing of DRT establishment

DRT location	Date	Jurisdiction
Kolkata	Apr 27, 1994	West Bengal, Andaman and Nicobar Islands
Delhi	July 5, 1994	Delhi
Jaipur	August 30, 1994	Rajasthan, Himachal Pradesh, Haryana, Punjab, Chandigarh
Bangalore	November 30, 1994	Karnataka, Andhra Pradesh
Ahemdabad	December 21, 1994	Gujarat, Dadra and Nagar Haveli, Daman and Diu
Chennai	November 4, 1996	Tamil Nadu, Kerala, Pondicherry
Guwahati	January 7, 1997	Assam, Meghalaya, Manipur, Mizoram, Tripura, Arunachal Pradesh, Nagaland
Patna	January 24, 1997	Bihar, Orissa
Jabalpur	April 7, 1997	Madhya Pradesh, Uttar Pradesh
Mumbai	July 10,6 1999	Maharashtra, Goa

Table A3: Checking parallel trends between group 1 and group 2 states (1983-1996)

	Icredit
Group1*year2	0.2466
	(0.427)
Group1*year3	0.2291
	(0.452)
Group1*year4	0.0827
	(0.784)
Group1*year5	0.0913
	(0.743)
Group1*year6	0.1929
	(0.467)
Group1*year7	0.3201
	(0.279)
Group1*year8	-0.1059
	(0.706)
Group1*year9	0.2956
	(0.289)
Group1*year10	-0.0294
	(0.914)
Group1*year11	0.2083
	(0.471)
Group1*post94	1.2056***
	(0.000)
District FE	Yes
Year FE	Yes
Observations	4858

p-values in parentheses

Notes: Dependent variable, $Icredit$ is bank credit to industry in a district year. Coefficient of interaction of Group 1 dummy with a year dummy indicates differential impact of Group 1 states over Group 2 states on credit supply in that year.Results for the control variables are suppressed.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Placebo test with personal loans

	(1) Unem(General)	(2) Unem(General)	(3) Conflict(G)
Personal loan	-0.0054		0.0036
	(0.263)		(0.184)
Literacy rate	-0.0092	-0.0096	-0.0154***
	(0.271)	(0.252)	(0.000)
Population density	4.1927**	0.6712*	1.0312***
	(0.033)	(0.063)	(0.001)
Cexpenditure	-0.0946**	-0.1024**	-0.0394***
	(0.030)	(0.022)	(0.006)
NSDP	-0.0010	0.0014	-0.0068**
	(0.863)	(0.819)	(0.012)
Lagged personal loan		-0.0000	
		(0.200)	
Urbanisation			-0.0017
			(0.315)
Inequality			0.0753
			(0.145)
Highways and roads			-0.0018
			(0.475)
District FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	10144	9691	7683

p-values in parentheses

Notes: Dependent variable in columns 1 and 2 $Unemployment(General)$ indicates unemployment in principal line of activity. Independent variable of interest in column 1 is personal loan and in column 2 is lagged personal loan. Control variables in columns 1 and 2 are the same as in Table VIII before. Dependent variable in column 3 $Conflict(G)$ takes a value of 1 in case of conflict involving death/property damage; 0 otherwise. Independent variables are the same as in Table III before. Standard errors are clustered at the district level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Robustness check with lagged credit supply

	Conflict(G)
Lagged Icredit	-0.0077***
	(0.000)
Urbanisation	-0.0013
	(0.420)
Population density	1.0803***
	(0.000)
Literacy rate	-0.0156***
	(0.000)
Inequality	0.0700
	(0.148)
Cexpenditure	-0.0399***
	(0.002)
NSDP	-0.0065**
	(0.016)
Highways and roads	-0.0022
	(0.390)
District FE	Yes
Year FE	Yes
Observations	7734

p-values in parentheses

$Conflict(G)$ takes a value of 1 in case of conflict involving death/property damage; 0 otherwise.

Independent variable of interest $laggedIcredit$ is bank credit to industry lagged by one year.

For description of other dependent variables, see Table 1 before. Standard errors are clustered at the district level

$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

Table A6: Robustness Check with Probit regression

	Conflict(G)
Icredit	-0.0044*
	(0.050)
Urbanisation	0.0061***
	(0.000)
Population density	-0.1087***
	(0.000)
Literacy rate	-0.0140***
	(0.000)
Inequality	-0.043604
	(0.619)
Cexpenditure	0.0002
	(0.987)
NSDP	-0.0080**
	(0.016)
Highways and roads	0.001
	(0.601)
Year FE	Yes
District FE	Yes
Observations	7767

Dependent variable, $Conflict(G)$ takes a value of 1 in case of conflict involving death/property damage; 0 otherwise

Independent variable of interest $Icredit$ indicates industrial credit in a given district-year.

See Table I before for definition of the other variables

Standard errors are clustered at the district level

Table A7: Robustness check with mining industry credit

	Conflict(G)
Mcredit	-0.0024**
	(0.045)
Urbanisation	-0.0244
	(0.230)
Literacy rate	0.0035
	(0.494)
Inequality	-0.1029
(0.202)	
Cexpenditure 0.0074	
(0.422)	
NSDP	0.0037
	(0.133)
ST share	-0.0029
	(0.485)
District FE	Yes
Year FE	Yes
Observations	792

p-values in parentheses

Dependent variable, Conflict(G), takes a value of 1 in case of conflict involving death/property damage; 0 otherwise

Independent variable of interest $Mcredit$ is credit to mining industry. See Table I above for definitions of other variables.

Since credit data on mining and quarrying classification are not available before 1996, sample sizes are smaller.

Standard errors are clustered at the district level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$