Investment after tragedy

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Abstract

This paper considers a community where contracting institutions are weak. If social sanctions against opportunism rise in times of stress, then some good projects may be born out of misfortune.

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1. Introduction

It is often said that tragedy brings out the best in people. In times of crisis, neighbors who never spoke to one another are willing to help one another rebuild. There is often an increased sense of common purpose, but this community spirit falls far short of the actual losses suffered. Further, it is often the case that aid, both foreign and domestic, tends to flow in after a natural disaster. Nevertheless, there is no reason to suppose that this aid does anything but attempt to rebuild the destroyed capital stock. Here we argue that, in contexts where contracting is particularly weak, a shift in norms in response to a tragedy can lead to good projects being undertaken that would have otherwise not been pursued without the disaster.

This paper begins by describing a socially beneficial project that is not initiated because of *ex post* opportunism. Then we introduce the concept of social sanctions and show how rises in community involvement and outrage against opportunism can reduce excessive, *ex post* wage demands. We put this in the context of a simple example, and then conclude.

2. Hold-up model

Here we present a stylized hold-up problem.[1] The essential feature of this problem is that the agent can renegotiate her contract after some funds have already been sunk. Further, we assume that the parties have been unable to design contractual remedies to correct this project and facilitate investment.

Suppose that there is a project, which we will for convenience call a "bridge," with a gross social benefit of V. It costs I to undertake. This project takes two periods to build by an agent. The agent incurs a cost of I_1 in period one and a cost of I_2 in period 2, where

$$I \equiv I_1 + I_2. \tag{1}$$

The gross social value also varies by period. The project has the characteristic that its net social benefit is only nonnegative if it is completed. For example, a "bridge" that only extends half the distance across a river is not worth producing, $V_1 - I_1 < 0$. Yet, it may have some benefit as a "fishing pier," $V_1 \geq 0$. Nevertheless, the net social surplus from building the bridge is weakly positive, $V - I \geq 0$.

$$\begin{aligned} &V \equiv V_1 + V_2 \geq I, \\ &V_1 < I_1 \;\&\; V_2 > I_2 \end{aligned} \tag{2}$$

An agent is paid wages each period of W_1 in period 1 and W_2 in period 2.

We will assume that the social welfare-maximizing principal with access to financial capital will approach a credit-constrained agent to build the bridge.[2] This

[1] Grout (1984) is the classic reference to the hold-up problem.
[2] The principal could be a private investor, a government entity, or non-governmental organizations (NGO) such as the World Bank or the charity Oxfam.

principal will fund all projects that have a positive (social) net present value (NPV) and thus do not divert investment funds from other socially valuable projects. This means that the bridge will be built if expected wages are less than or equal to the gross value of the project, $W_1 + W_2 \leq V_1 + V_2$.

Further, we will assume that this principal will maximize social surplus from the present period going forward, and will fund the bridge in period 2 if $W_2 \leq V_2$. If the principal could *commit* to be tough in period 2 and not pay any $W_2 > V_2 + V_1 - I_1$, then it would be a subgame perfect Nash equilibrium that the bridge would always be built. The principal's objective of maximizing social surplus going forward means that the principal cannot commit to refuse high wage demands of $V_2 \geq W_2 > V_2 + V_1 - I_1$.

The agent, on the other hand, wishes to maximize her profit $\Pi = W_1 + W_2 - I_1 - I_2$. Further, long-term, multi-period contracts cannot be enforced with the agent. The principal can be counted on to compensate the agent for any promised price. Nevertheless, the agent cannot commit to honor multi-period contracts. Further, we will assume that the agent must be compensated for all costs incurred each period. Therefore, the minimum wage that the agent must be paid in period 1 to produce is $W_1 \geq I_1$.[3]

Let us also assume that the principal has all the bargaining power at the outset of the project, but the agent has all the bargaining power in the middle of the project in period 2. The hold-up problem here stems from fact that the agent has all the bargaining power after the investment is partially sunk. The social planner cannot prevent the agent from renegotiating the compensation arrangement once the first section of the bridge has been completed. Using backwards induction, regardless of what period 2 wage the agent originally agreed to receive, the agent will demand that she be paid V_2 in period 2. Therefore, without social sanctions the principal will expect to pay at least $I_1 + V_2$, which exceeds the gross social benefit of $V_1 + V_2$. Therefore, the principal will never commission the bridge.

Proposition 1
It is a subgame perfect Nash equilibrium that the "bridge" will not be commissioned without social sanctions.

3. Social Sanctions

The opportunistic behavior of the agent occurs, in part, because the social planner cannot impose penalties for opportunistic behavior. Here we argue that penalties are functions of the social environs that the agent inhabits. Community monitoring and intolerance of opportunism will help prevent hold-up problems soon after a crisis. The tragedy temporarily works to intensify the community involvement and the community's level of devotion to the "social good."

If the agent can renegotiate without her peers observing this behavior, she need not fear social sanctions. On the other hand, if the sanctions have no teeth it does not

[3] This assumption is necessary, but not unreasonable in the context of a developing economy. If the agent can behave opportunistically with the principal, she also will likely be able to behave opportunistically with potential investors. This opportunism will likely make the agent credit constrained. If an agent has a beginning wealth of zero or cannot commit her wealth to the project, then social planner must pay the agent's costs.

matter if the agent operates in secret or not. Suppose there is a social sanction function $s(p, r)$, where p is the probability of the community detecting the agent's opportunism, and r is the "rage" or penalty the community is willing to impose on an agent who has been discovered to be opportunistic.

The probability of detection, $1 \geq p\left(\frac{\mu}{M}, W_2 - I_2\right) \geq 0$, is a function of two arguments. There are M members of the community, $\mu \leq M$ is the number of members who are actively monitoring opportunism. $W_2 - I_2$ is the measure of the opportunism of the agent. Let us denote partial derivatives of the first and second arguments by the subscripts 1 and 2, respectively. The probability of detection is increasing in both the fraction of the population monitoring opportunism, $\frac{\mu}{M}$, and the greed of the agent, $W_2 - I_2$. Thus, $p_1, p_2 > 0$. Further, monitoring and the agent's payoff from opportunism are weakly complimentary. Therefore, the cross partial is $p_{12} \geq 0$. In general, we would assume that no monitoring, $\mu = 0$, would lead to a zero probability of detection, $p(0, W_2 - I_2) = 0$. In the aftermath of a natural disaster, it is not uncommon for communities to participate *en masse* in public works projects. If many members of the community begin to work beside the agent, then it will be much harder to conceal opportunism.

The social outrage is also a function of two arguments $r(\rho, W_2 - I_2) \geq 0$. $\rho \geq 0$ is the exogenously determined level of rage against opportunism. In times of tragedy, one's peers may react very negatively to opportunism. For example, if the "bridge" is necessary to transport supplies to starving communities on the other side, profiteering may not be tolerated. Nevertheless, if the agent is needed to resurface an already well-paved road, social outrage may be minimal. High ρ means high outrage. Thus $r_1 > 0$. Further, like detection outrage is increasing in the level of profiteering and $r_2 > 0$. Finally, higher levels of exogenous outrage ρ and profiteering $W_2 - I_2$ are weakly compliments $r_{12} \geq 0$. No outrage, $\rho = 0$, or no profiteering, will generally lead to no social sanctions.

Let us decompose the social sanction function into two components.

$$s(p,r) \equiv p\left(\frac{\mu}{M}, W_2 - I_2\right) r\left(\rho, W_2 - I_2\right) \geq 0 \qquad (3)$$

The expected sanction, $s(\bullet)$, is the probability of detection, $p(\bullet)$, times the punishment for detection, $r(\bullet)$.

In period 2, when renegotiating her compensation, the agent will want to choose a W_2 that maximizes her expected profit incorporating her expected social sanction.

$$\arg\max_{W_2} \quad E\{\Pi_2\} = W_2 - I_2 - p\left(\frac{\mu}{M}, W_2 - I_2\right) r(\rho, W_2 - I_2) \qquad (4)$$

We will assume that $E\{\Pi_2\}$ is twice differentiable and concave with a negative second derivative everywhere. Under normal circumstances in disinterested communities where contracting institutions are weak, one may expect that the social sanctions function would be sufficiently weak such that the agent would choose the maximal $W_2 = V_2$. Let us concern ourselves with the cases where there is an interior solution where expected profit is maximized at $W_2^* \in (I_2, V_2)$. In this case, the first order condition (FOC) is as follows:

$$f \equiv \left.\frac{\partial E\{\Pi_2\}}{\partial W_2}\right|_{W_2=W_2^*} = 1 - p_2^* r^* - p^* r_2^* = 0. \tag{5}$$

The superscript stars indicate that the functions are evaluated at W_2^* while the subscripts signify that the first partials of the second argument, $W_2 - I_2$, of the probability of detection function and the outrage function, respectively.

We have defined the FOC as the function *f*. The second order condition,

$$f_{W_2} = -(p_{22}^* r^* + 2p_2^* r_2^* + p^* r_{22}^*) < 0, \tag{6}$$

holds by assumption. Taking the partials of *f* with respect to the exogenous parameters μ and ρ,

$$\begin{aligned} f_\mu &= -\frac{1}{M}(p_{12}^* r^* + p_1^* r_2^*) < 0, \text{ and} \\ f_\rho &= -(p_2^* r_1^* + p^* r_{12}^*) < 0. \end{aligned} \tag{7}$$

Combining equations (6) and (7), the second period wage demands of the contractor are unambiguously decreasing in the monitoring level and the level of outrage.

$$\left.\frac{\partial W_2}{\partial \mu}\right|_{W^2=W^{2*}} = -\frac{f_\mu}{f_{W_2}} = \frac{1}{M}\left(\frac{p_{12}^* r^* + p_1^* r_1^*}{p_{22}^* r^* + 2p_2^* r_2^* + p^* r_{22}^*}\right) < 0 \tag{8}$$

$$\left.\frac{\partial W_2}{\partial \rho}\right|_{W^2=W^{2*}} = -\frac{f_\rho}{f_{W_2}} = \left(\frac{p_2^* r_1^* + p^* r_{12}^*}{p_{22}^* r^* + 2p_2^* r_2^* + p^* r_{22}^*}\right) < 0 \tag{9}$$

Proposition 2

Suppose that the agent would demand neither the maximum wage nor the minimum wage in period 2 before the shock. A small increase in public monitoring, μ, or social penalties, ρ, decrease the agent's period 2 wage demands.

This follows from the comparative statics in equations (8) and (9) above.

As long as $W_2^* + I_1 \le V_2 + V_1$, social sanctions can guarantee that the "bridge" is built. Otherwise, it is a subgame perfect Nash equilibrium that the bridge is never commissioned. Therefore, we could imagine that a tragedy, such as a natural disaster, may lead to a rise in μ and ρ and a fall in the agent's wage demands. Suppose that before the tragedy, the bridge was never commissioned, despite its social benefits. In some cases after the tragedy, rises in μ and ρ will cause the equilibrium wage demand to fall to the point where it is a subgame perfect Nash equilibrium that the bridge is built.

4. Worked out example

For purposes of illustration in this section, we will write down an explicit sanction function that will lead to a closed-form solution. Suppose that

$$1 \geq p\left(\frac{\mu}{M}, W_2 - I_2\right) \equiv \frac{\mu}{M}\left(\frac{W_2 - I_2}{V_2 - I_2}\right) \geq 0, \tag{10}$$

and

$$r(\rho, W_2 - I_2) \equiv \frac{\rho}{2}(W_2 - I_2). \tag{11}$$

Plugging in equations (10) and (11) in to the agent's objective function,

$$\arg\max_{W_2} \quad W_2 - I_2 - \frac{\rho}{2}\frac{\mu}{M}\frac{(W_2 - I_2)^2}{V_2 - I_2}. \tag{12}$$

The first and second order conditions are

$$\frac{\partial E\{\Pi_2\}}{\partial W_2} = 1 - \frac{\rho\mu}{M}\frac{W_2^* - I_2}{V_2 - I_2} \geq 0, \; \& \tag{13}$$

$$\frac{\partial^2 E\{\Pi_2\}}{(\partial W_2)^2} = -\frac{\mu}{M}\frac{1}{V_2 - I_2}\rho < 0 \tag{14}$$

For a given set of parameter values,

$$W_2^* = \min\left\{\frac{M(V_2 - I_2)}{\mu\rho} + I_2, V_2\right\}. \tag{15}$$

In the figure below, we plot the agents' wages as a function of the multiple of the monitoring and sanction parameters. Higher relative levels of monitoring, $\frac{\mu}{M}$, compliment higher sanctions, ρ. Investment is only feasible when the agents' gross wages are less than social benefit. That occurs at $\left(\frac{\mu}{M}\rho\right)_{\min}$. This is where the period 2 wage is the maximum for which investment is feasible $W_2^* = V_2 + V_1 - I_1$. (The period 1 the minimum wage is I_1.) Substituting this into the first-order condition in (13), we can solve for $\left(\frac{\mu}{M}\rho\right)_{\min}$.

$$\left(\frac{\mu}{M}\rho\right)_{\min} = \frac{(V_2 - I_2)}{(V_1 - I_1) + (V_2 - I_2)} > 1 \qquad (16)$$

Equation (2) allows us to conclude that $\left(\frac{\mu}{M}\rho\right)_{\min}$ in (16) exceeds unity. This means that, in this example if $\frac{\mu}{M}\rho$ is less than or equal to 1, then no investment will be undertaken.

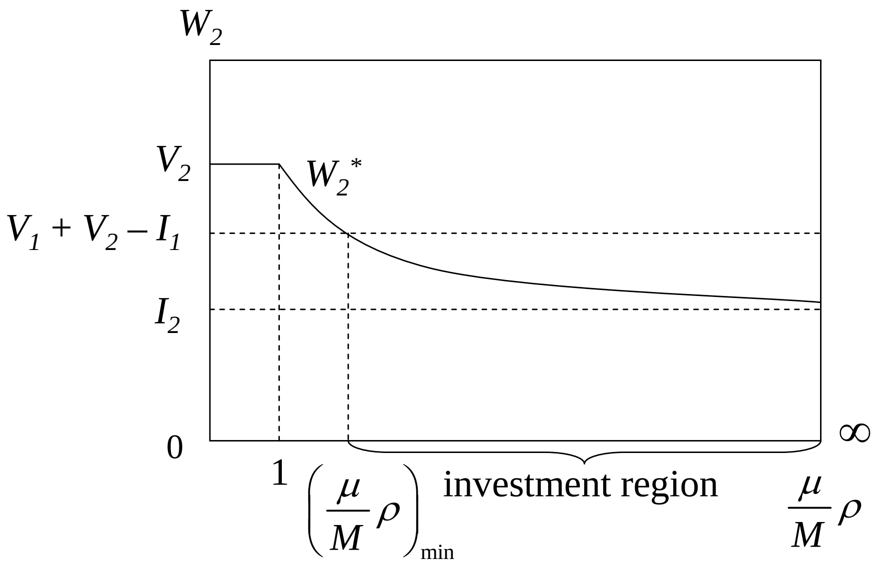

Figure 1:

Agents' period 2 wage, W_2, **as a function of the expected social sanctions,** $\frac{\mu}{M}\rho$.

5. Conclusion

This paper has presented a theory of how some good can come of out a community disaster. This model is meant to apply to developing economies where socially profitable investments are "held up" by contracting problems. After a disaster community intolerance for opportunism may serve as an alternative enforcement mechanism that facilitates valuable investment. The model also demonstrates that long-term gains rely on the affected community actively participating in the reconstruction effort.

Reference

Grout, P., (1984) "Investment and Wages in the Absence of Binding Contracts: A Nash Bargaining Approach," *Econometrica* **42**, 449-460.