# Econ 615 Prof. Rust – Assignement 1

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October 25, 2012

**Abstract**

*In this short essay, I compare and contrast two different methodologies used for analyzing outcomes of policy interventions in development economics.* The first paper, Chattopadhyay-Duflo (2004), from heron referred to as CD, used a "Reduced form" methodology to analyze the effect of a policy requiring that more pubic offices in India be held by women. The second paper, Kaboski-Townsend (2010), from hereon referred to as KT, employs a "Structural Modeling" methodology for analyzing the effect of of a microfinance program in Thailand. In this essay, I will: a) dissect each methodology and how it is applied, b) offer pros and cons about each methodology and their assumptions, and c) posit how well each paper answered questions about the empirical issues at hand.

In the first paper, CD employ a standard reduced form methodology, where they collect data and perform statistical analysis to evaluate the effect of the policy intervention in India. They methodology begins with the identification of a natural experiment, where the treatment groups must be randomized. Luckily, CD identifies a policy intervention that provides exactly that: in the 1990s, a law was passed in India requiring that one-third of Village Council head positions in India be randomly reserved for a woman. Since the Village Council leader (or "Pradhan") has a major impact on how public village funds are implemented, CD saw how the reservation in favor of women affects the types of public goods invested in by the village. What they found is that the gender of leaders directly affects the infrastructure investments, and that investments largely reflected the *preference* of the gender. For example, women being the primary household caretakers may be more interested in clean water, while men who travel to work may be more interested in roads.

To perform this reduced form, CD must establish a framework for their analysis. First, CD needs to borrow a model-framework already developed in Osborne and Slivinski (1996), Besley and Coate (1997), and Downs (1957), where the elected representatives are assumed to be "Citizen Candidates." All the underlying assumptions about behavior of the Pradhan is assumed to be reflective of a Citizen Candidate – where citizens decide whether to run for office by guessing the probability of being elected against the fixed cost of running for election. Second, the Candidate makes this decision each period, and they must evaluate their payoffs at each period.

However, even by borrowing from this framework, additional assumptions need to be made to account for the idiosynchrasies regarding India. For example, even if we assumed that voters had full information and voted strategically, the final outcome may not be what the median voter wants, which contradits the Downsian prediction of an election that the framework is based on. Beseley-Coate offer a remedy where there may be an equilibrium with two candidates that reflect the average feelings of the median voter, but are not exactly aligned from the median voter. While theoretically this mixed-strategy outcome is correct, real life elections can only have a pure-strategy outcome, as only 1 candidate can assume office – thus they restrict their analysis to 3 candidates.

Before CD can perform any statistical analysis, they must also impose a string of propositions and lemmas that narrow down the set of acceptable equilibria. For example, they must assume ex-ante that there is no possible equilibrium where a women runs in absence of reservation, which may or may not be true. Heteogeneity in villages may lead us to find that some villages are much more progressive as far as gender equality, but we assume these outcomes away ex-ante, or else we cannot find the effect of the policy intervention (Proposition 1 & Lemma1). The set of possible outcomes is restricted in advance of the analysis, before the effects are even evaluated. Conversely, the conclusions we make about the intervention are also restricted to the space we have created through our data and the assumptions.

CD also admit that model ignores many possible externalities regarding the reservation system. For example, there is no mechanism to understand who people who strategically vote in an election, only how they end up voting. Since we do not have a grasp of the underlying mechanisms, we cannot tell evaluate the effects of incentives on the voting system and candidate behavior. CD say that they control for these incentives by using exogenous factors, but that still does not help us understand the underlying mechanism, it only helps us prevent its affect on the analysis.

The final CD model employs a relatively simple form of $Y_{ij} = \blacksquare_1 + \blacksquare_2 R_j + \blacksquare_3 D_i R_j + \blacksquare_l d_{il} + \blacksquare_{ij}$, and reveals powerful, statistically significant findings. The local treatment effects are measured to be large for the policy intervention, and CD provide amble support for the idea that requiring female representation is not only a good way to create diversity in public good provisions, but one of the only effective ways to do so in a society like India's.

In the second paper, KT utilize a structural modeling approach to evaluate the impacts of a microfinance intervention in Thailand. With a structural approach, the underlying model is hypothesized based on what the researchers believe the underlying mechanisms governing the agents behavior are. This hypothesized model is often informed by the data and preliminary reduced-form results, but offers the opportunity for predictive analysis too. KT speak against borrowing an already developed model like the Permanent Income Model, which is a perfect credit model, because it would have trouble explaining non-standard behavior assumed by the model, like the large increase in borrowing, which may or may not be true.

While their model is informed by the literature (Chiappori, 2008; Aiyagari, 1994; Carroll,1997; Deaton, 1991), it is not taken directly from there. We can think of the the hypothesized model, as an androgynous skeleton of what will become a fully unique person with specific characteristics. Also, the previous literature is not prepared for the types of behavior that surrounds microloans. For example, the authors believe that the interest on a microloan may induce behavior that is not indicative of either a direct transfer or a standard loan with interest, which is only what previous literature addresses. The authors note that "microfinance program is potentially less beneficial because households face the interest costs of credit". Since the availability of microloans may induce fundamentally different behavior in agents, that behavior needs to be accounted for in the model. The authors also admit to other features that could hurt the results, like how villages are heterogenous in size and the policy intervention can affect large and small villages very differently. A structural model that assumes homogeneity that agents, regardless of the size of their village, will behave similarly, however, ex-post we see that the intervention actually lends itself differently to villages of different sizes. Otherwise, we would have to create a new model for each village size, and that would make it hard to see the varying distribution of effects across all villages.

The basic model is hypothesized as a CRRA utility function for an infinitely lived agent, who is subject to reasonable constraints. KT assume linearity for the constraints to make the math easier, and that the household makes sequential decision about: consumption, low yield liquid savings, high yield illiquid investment, and default. The value function model takes the form:

$V(L_0, I_0^*, P_0; \underline{s}) = \max_{\{C_t>0; S_{t+1}; D_{I,t}\}} E_0[\sum_{t=0}^{\infty} \beta^t \frac{C^{1-\rho}}{1-\rho}]$

(1) :$C_t + S_t + D_{I,t} I_t^* \leq L_t$.

(2) :$L_{t+1} = Y_{t+1} + S_t(1+r)$

(3) :$Y_{t+1} = P_{t+1} U_{t+1}$

(4) :$P_{t+1} = P_t G N_{t+1} + R D_{I,t} I_t^*$

(5) :$I_t^* = i_t^* P_t$.

(6) :$S_t \geq \underline{s} P_t$.

where (1) is the standard household budget constraint, (2) is the income based on permenent income and savings components, (3) is the rise permanent income, (4) the investment choice return based on rates, (5) the investment size, and (6) the borrowing constraint. The problem is defined such that all constraints are linear in the permanent component of income, so the value and policy functions can be normalized by income. The final result will be an equilibrium form for this stationary, recursive problem.

Before the model is complete, we must make assumptions about the boundary conditions and how shocks actually enter the system, i.e. what happens in case of default. The normality assumptions about shocks is strong, and we assume that when a household is in default that the following is all true: $C_t = \underline{c}P_t; S_t = \underline{s}P_t; D_{I,t} = 0$. The nice thing about this is that we allow the model freedom to hit the boundary, and do not assume in advance that a boundary condition is either undesirable or unrealistic.

By employing our assumptions of linearity, boundaries, and we limit the heterogeneity of the model. Lowering the heteroganaity of the model helps us fight the "curse of dimensionality", giving us a state space $\{L, I^*, P\}$ and param space $\{r, \sigma_N, \sigma_u, G,\underline{c},\beta, \rho, \mu_i, \sigma_i,\underline{s}\}$. Although an explicit, closed form solution is nearly impossible, we can reasonably expect a computer to numerically solve for a stationary equilibrium.

We then normalize the model by incomes, and find ourselves with the final recursive form:
$v(l, i^*) = \max_{\{c,d_I\}}[\frac{c^{1-\rho}}{1-\rho} + \beta E[(p')^{1-\rho}v(U' + \frac{(1+r)(l-c-d_I i^*)}{p'}, i^{*\prime})]]$
$\phi : (l - c - d_I i^*) \geq \underline{s}$
$p' = GN' + Rd_I i^*$

the resulting Euler Equation looks very standard also : $(c_*)^{-\rho} = \beta(1 + r)E[(p')^{1-\rho}\frac{\partial v}{\partial l}(U' + \frac{(1+r)(l-c-d_I i^*)}{p'}, i^{*\prime})]$,

and we get out Law of Motion from substituting in expressions for liquidity, income and default: $E[D_{def,t+1}|S_t, P_t, D_{I,t}, I_t^*] = \Pr[U_{t+1} < (\underline{s} + \underline{c}) - \frac{S_t}{P_t N_{t+1}G+RD_{I,\,t}I_t^*}]$.

The above hypothesized model is then "calibrated" by pre-intervention data and Method of Simulated Moments optimal weighting matrix, so that the model is not just reflective of the behavior of all people, but of the Thai people.

The pre-intervention data takes observable characteristics of the Thai economy and uses that information to customize the parameters of the model to be reflective of a Thai economy. The pre-program data are econometrically observable, like the rates of: Borrowing, Default, Investment, and Growth. However, unobservables in the model and heteroganeity can pose a problem to this structural approach. For instance, when observe consumption variation, we hope that we are observing household responses to income shocks, however, it may just be predictable responses to changes in household composition. While we cannot fix some of these problems, KT do their best to make note of them. Also, KT often use proxies for rates that cannot be directly observed in a traditional sense. For example, if you want to know an interest rate in a US town, you go to the nearest bank in that town and ask them for their rate. However, in a Thai village, the lack of formal banking means that KT used proxies, like with calibrating rate R for investment, they observed changes in physical capital stock instead. The likelihood function then would take the form of $Y_t = [P_{t-J}G\prod_{j=1}^{J} N_{t+1-j}]U_t + R[\sum_{j=1}^{J} I_{t-j}G^{j-1}\prod_{j=1}^{J} N_{t+1-k}]U_t$, where first term is income from invest before the intervention, and second term is income from investment after t-J.

Finally, KT input that shock of the policy intervention, and see if the models reaction is indicative of what happens in real life. To check the "real-life effect", they create a reduced-form benchmark for each of the observable characteristics (ie for Consumption it is $C_{n,t} = \sum_{j=6,7} \alpha_{C_j} \frac{950000}{\#HH \text{ in village v}} I_{t=j} + \theta_{C,t} + e_{C,n,t}$). Then, they use a common test is the Chow Test, which sees how well the model predicts versus the reduced form outcomes. By running the model 500 times, through 500 generated datasets, KT find that their models predictions are actually near the real world outcomes, as are their standard errors.

*The CD and KT methodologies for analyzing the effects of a policy intervention have both Pros and Cons. This section I will illustrate with bullet points.*

The advantages of the CD reduced-form approach are:

- that is uses pre-vetted models provided in the literature
- is computationally non-intensive
- the coefficients on the model give a clear interpretation of the local effects

The advantages of the KT structural modeling approach are:

- involves the creation of a non-generic model that applies to a type of economic situation
- can be calibrated to apply to different economic environments
- provides a predictive model that has power beyond the bounds of the dataset
- can be checked often times through a reduced form approach
- we have an opportunity for normative policy evaluation

The disadvantages between CD's Reduced Form (RF) and KT's Structural Modeling (SM) approaches are as follows:

- The SM approach does not give us an explicit, closed form solution, and finding equilibria numerically can be computationally intensive.
- The RF can only tell us the local treatment effects at a given space and time, and often assumes away ex-ante any possibilities nearing the boundaries of the dataset
- as for modeling human behavior, it is impossible for SM to account for all aspects of human decision making in a basic equation, thus leaving a very open-ended model; conversely, RF analysis uses Propositions to restrict the set of possible behavior, which may eliminate outcomes that otherwise may happen in the real world.

- the SM approach has a difficult time modeling non-linear thresholds in human behavior, for example, the "investment cliff" where in the real-world, households with enough income would suddenly start investing, and that non-linear threshold may not have been anticipated by the linear constraints of the model, or may have even been indicative of the culture of the area that was discovered ex-post.

- SM allows relies on a project size and investment that is stochastic, while a RF result from a randomized trial can be controlled to account for such factors through the experimental design to get a more exact approximation of the marginal effects.

- RF makes a very strong linearity assumption, supposing that the net effects can be measured just subtracting one effect from another.

*In conclusion, each methodology does an adequate job in answering the questions that are posed, but each methodology also has a lot to learn from the other.* CD found that the gender of the Village leader in fact does have a statistically significant effect on the types of infrastructure the village invests in. Likewise, KT found that the microfinance intervention in Thailand, did have an effect, but may not have necessarily been worth the cost. Also, KT found higher consumption driven by non-durable consumption and services, but little changes in investment, which is consistent with other RF findings (Duflo et al 2010). For CD, although a RD analysis gives a good approximation of the marginal effect of an increase in female representation, a structural modeling approach may be able to help them find a steady state outcome for exactly how many women will end up in future offices or the steady state investment levels of different types of infrastructure. For example, the RF does not tell us about the evolution of female representation or the steady state of goods to be supplied to an economy that eventually reaches a 50/50 split of representation between men and women. Likewise, KT can use a reduced form approach to get more exact estimate about agents explicit reactions to interventions, instead of assuming that the SM approach can capture the full magnitude of the agents behavior, as with the aforementioned "investment cliff" that the KT model did not foresee.