DIMINISHED-DIMENSIONAL POLITICAL ECONOMY

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ABSTRACT
Economists’ policy advice is based on models of responses by a variety of economic entities to policy adoptions. There is compelling evidence that these entities do not optimize in all the fashion that mainstream economics assumes. Rather, they limit decision-making to solving problems of much smaller dimensionality. We consider how political economy goes awry when ignoring diminished dimensionality, and some research avenues opened up by this realization.

1. Introduction
Political economy refers herein to that broad swath of economic knowledge and scholarship in which public-sector economic actions or decisions are considered, or the impact of an economic or social policy is analyzed. Mainstream political economy relies on the optimization tools of neoclassical economics to characterize both the behavior of households and firms in response to policies, and the optimal choices of public-sector decisions and policies.

Mainstream political economy thus posits that firms and households maximize an objective function that takes as arguments perhaps thousands of relevant variables such as net demands or supplies of vectors of commodities, subject to constraints that may lie in even larger vector spaces. There is compelling evidence (confer Harstad and Selten, 2013) that human decisionmaking does not solve such large-dimensional problems.\textsuperscript{1}

Whether the behavior can be considered consistent with first-order conditions or not, it is clear that the dimensionality of human decisionmaking is of a far smaller order than neoclassical economics assumes. This evident conclusion points to fallacious reasoning in mainstream political economy. When households and firms behave via a series of decisions that come from dealing (either optimally within its scope, or via some pattern of aspiration formation and adaptation) with fewer variables in any decision, political economy must be re-thought to take this into account.

In pointing this out, the current essay indicates, in broad scope and with but preliminary import, the sorts of changes needed. It also lays down a welcome mat to a broad range of research topics, most challenging.

2. Evidence
It is true that problems like
\[
\text{max}_x U(x_1, x_2, \ldots, x_{1000}) \text{ s.t. } p_1 x_1 + p_2 x_2 + \ldots + p_{1000} x_{1000} = Y
\]
can be represented as
\[
\text{max}_{x_1, x_2} V(x_1, x_2) + W(x_1, x_3, \ldots, x_{1000}) \text{ s.t. } p_1 x_1 + p_2 x_2 + Z(x_3, x_4, \ldots, x_{1000}, p_3, p_4, \ldots, p_{1000}) = Y,
\]

\textsuperscript{1} In Harstad and Selten (2013), we proposed that optimization models do not accord with human behavior, and bounded-rationality models are needed (despite the added difficulties in competing intellectually). Here we focus on the dimensional size of problems solved behaviorally, and allow for modeling that might or might not treat the smaller problems faced as being optimized.
but such a formulation implies that, for each pair \((x_1, x_2)\), the remaining variables are set at their optimal values given prices and income. It maintains the presumption that a change in any price \(p_j\) leads to re-optimizing \((x_1, x_2)\). This is not the behavior we see. (Indeed, once the realistic assumption is made that many of the variables in classical optimizations are binary or integer-valued, such problems are NP-complete, that is, not computationally manageable.)

2.1. Households

Households tend to segregate purchase decisions into categories, with any optimization only coming within categories. Income and other sources of purchasing power are segregated as to categorical purpose. While neoclassical models suggest that any price or income change or new option or altered perceived quality of a commodity calls for a complete re-optimization, shifting of funds across categories occurs far less frequently.

Several researchers (see, for example, Collins, Morduch, Rutherford and Ruthven, 2009, and references there) have found that households have multiple budget constraints for multiple categories of spending, and often physically segregate segments of cash holdings according to the intended purpose. Only in rare and extreme occurrences (such as unexpected employment or unemployment or major medical expenses) are funds moved from one segment to another, or used for a different purpose than their physical placement had indicated. Dupas and Robinson (2013) find that funds set aside by Kenyans for emergency medical expenses are not tapped for preventive medical purposes. Villa, Barrett and Just (2010) discover that the income elasticity of demand for nutrition in East Africa can be essentially zero for some sources of purchasing power, yet near one for other sources.

Virtually any economic policy will see different responses from households behaving in this way than from \(bomini\) economicus. A change in some tax or subsidy program may find responsiveness only in a small-dimensional subset of a household’s behaviors.

2.2. Firms

Selten, Pittnauer and Hohnish (2011) find that financially incentivized human subjects in an informationally-realistic dynamic-monopoly laboratory setting select a small number of goals, each less encompassing than profit, and pay attention in a single time period to but one of the selected goals, temporarily ignoring others. Arad and Rubinstein (2012) observe a vast number of subjects in a complex, symmetric game that is essentially a multi-market duopoly. All subjects are observed to edit the strategy space into a few dimensions, and then consider these dimensions seriatim. The thinking is completely antithetic to the best-response calculations that would lead to a mixed-strategy equilibrium.

Abundant evidence accords with this conclusion that firms solve problems whose dimensionality is diminished relative to the neoclassical model. The divisions of nearly all corporations work to parcel, if not outright partition, the dimensions of profit maximization across such divisions as production, distribution, marketing, finance, product development. The agendas for meetings of top executives may be logistics, or lobbying, or potential mergers, or assembly-line streamlining, or advertising... Every meeting focuses on a small-dimensional subset of the profit objective, with the remaining dimensions temporarily unattended.

2.3. Legislative bodies

There are, of course, significant differences between the way various legislative bodies operate, even between nations in the European Union, let alone across continents and ideologies. Yet these differences

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2 Patterns such as some in a purse, more in a kitchen cupboard, emergency funds under a mattress, savings for a particular purpose in a tin can buried in the back yard, are common across cultures and continents.

3 Thaler (1999) lumps many such behaviors under the label “mental accounting.”
don't come close to economists' neoclassical model. Common to nearly all are: single-item agendas, single-item bills, dimensions of governance parceled out across legislative committees with small-dimension spheres of attention, or control or influence. Fact-finding investigations show the universality of single-issue concerns.

2.4. Executive and administrative governmental bodies and functions

Key meetings in the executive branches of governments focus on one or two issues just as much as do corporate meetings. Divisions within executives roughly parallel those of legislatures: defense, education, foreign affairs (notably absent is any division corresponding to appropriations). Major initiatives are typically broken down into segments, each of which is single-issue or nearly so. The manner in which they are segmented may greatly influence the outcome, making useful analyses less global. Regulatory bodies are also, quite naturally, split into regulation of particular industries or functions. What is unnatural is the mainstream political-economic model of a government considering all of its actions in terms of maximization of some welfare function.

2.5. Judiciaries

By their nature, judiciaries are inherently concerned with a single issue at a time. The presence of a judiciary insures that a government as a whole never behaves the way economists assume. This is also a good place to note that objectives of various portions of a government often imply pursuit of quite incongruent goals, making the notion of public-sector maximization of social welfare a farce.

2.6. NGOs

Charities and other non-governmental organizations may be more than single-issue, but tend to have a quite narrow focus. In our experience, charities never seem to consider how their own fundraising efforts might crowd out donations to other organizations with largely congruent goals, and may yield little or no net contribution to the causes of mutual concern. The few organizations that might possibly look like neoclassical optimizers (if you don't look too closely) are such think tanks as the Brookings Institution or RAND. We have spent too much time looking closely at universities to imagine there is anything all-encompassing, let alone rational, about the economic decisions of the vast majority of them.

3. Scope for bounded-rationality modeling

Such boundedly rational models as that characterized by search for alternatives, satisficing, and aspiration adaptation (Simon, 1955, Selten, 1998) dovetail nicely with diminished-dimensionality decisionmaking. Segregated decisions become natural. Newell and Simon (1972) and Nelson and Winter (1982) include examples of how such decisionmaking responds to a change in an economic policy. Rather than continual re-optimization of all variables, major external events become causal elements for decision reconsideration.

Despite its behavioral realism, bounded rationality presumably cannot be the main modeling tool for the political-economy problems requiring analysis and prescriptive advice today. For all its affinity with small-dimensional problems, bounded rationality does not support isolation of economic forces in the way that the comparative statics of optimization models can. Aggregation, dynamics, and welfare analysis remain problems that are likely to plague boundedly rational models for decades (Harstad and Selten, 2013).

A principal political economy role of the bounded-rationality literature is to suggest by analogy what sorts of constraints to build into, and of robustness checks to evaluate, optimization-based models of economic policy.
4. Caveats to optimization-based analysis

Neoclassical models can lead to incorrect and unreliable policy analysis and advice when utilizing assumptions that all household marginal rates of substitution and all firm marginal rates of transformation match price ratios. Thus, for example, optimization-based models of households' responses to an increase in a carbon tax will be more valuable and useful if they imply that a one-time, large, permanent increase leads to quite different behavior than a series of small increases (perhaps quarterly or monthly) that end up in a few years reaching the same permanent carbon tax rate.

Each small-step increase may well lead a household to respond only within the budget that handles the relevant purchases. Thus, small but not negligible increases in electricity bills relative to last month or last quarter may not lead to any reduction in a household's grocery-store purchases, since those are made from a separate budget unaffected by the costs of electricity. This may persist until such time as a major change in circumstances forces the household to reconsider its assignments of purchasing power to its sundry budgets. So grocery-store purchases may suddenly reflect the cumulative impact of perhaps a dozen or perhaps twenty months' electricity-price increases at the time when a family member leaves the household to go to college or an extended-care facility, or there is a gross change in family income. This suddenly attended change, not directly related to the set of gradual carbon-tax increases, causes the current carbon-tax implications to be considered in a rare reassignment of a new level of purchasing power to all of its budgets.

In sharp contrast, a sudden, permanent shift to a much higher carbon tax will quickly lead to simultaneous increases in: electricity bills, the price of gas, airfares and public transport costs, prices of all retail products containing a significant petrochemical component, and all retail products for which transport costs are a significant share of total costs. Such a shift forces a household to commence that rare reassignment of purchasing power to all of its budgets, a reassignment directly created by the large, sudden carbon-tax increase.

A similar consideration arises in the response of firms. Gradual carbon-tax increases do not per se create interdivisional reallocations, although at some point an external event might. Any time a logistics manager faces a fleet-replacement decision, current fuel cost will influence the extent to which more efficient vehicles are leased or bought. But that decision does not feed back into decisions about the quantities to produce of products requiring shipping, as neoclassical models assume. A task force formed to figure out firm-wide response to one large, permanent, carbon-tax increase will interact with a much larger set of the firm's decisionmakers than would happen with a series of gradual increases.

So the welfare costs of macroeconomic frictions that would be decried, should carbon-tax rates at once be hiked to appropriate levels, presumably ought to be weighed against the reduced dimensions in which economic agents will react to gradual carbon-tax increases. Optimization-based analyses insensitive to these diminished-dimensional issues may be hugely misleading.

A related but distinct caveat: suppose advice on an economic-policy change is based on a classical comparative-statics analysis. The underlying re-optimizations assumed to be full-dimensional will only be realized in the more-closely-related dimensions (these may be different dimensions for consumers than for producers), much as just described for the carbon tax. It follows that the range of circumstances in which the sign of the comparative-static effect might be robust enough to be reliable are a large superset of the (likely tiny) range of circumstances in which the estimated magnitude of the comparative-static effect might be trustworthy.

So it is possible that a neoclassic model of the efficiency gain from public expenditure $X$, if it incorporated the efficiency cost of tax or debt finance, might yield a reasonably reliable conclusion that the
net gain is significantly positive, while comparison of the estimated net efficiency gain for X relative to alternative Y might be far from reliable.

5. Adapting optimization models

A reasonable expectation has optimization models of, for example, the travel expenditures of a household being more useful for political economy than boundedly rational models of those expenditures, despite the superior descriptive realism of the latter. In this way, a household may usefully be modeled as a collection of within-category optimizations that are only combined into a single, purposeful decision when some external event or collection of events forces combining the categorical decisions. A corresponding model of a firm—as a collection of optimizations only within partitioned dimensions that are more than haphazardly interrelated only following sizable external occurrences—may also be useful.

5.1. Aggregation

Macroeconomic political economy, being part of macroeconomics, is largely based on a representative consumer model, and often based on assumptions that the underlying system of responses to changes is a linear system. Linear responses by a large number of agents assumed all to respond identically actually create few problems of aggregation, beyond the need to explicitly acknowledge the high degree of dependence on stringent assumptions. Within such a linear system, correlations are vanishing or at least unsystematic (Selten, 1970), which is not too bad a fit with the reality that individual agents are responding via low-dimensional decisionmaking.

More microeconomic consideration of the aggregate behavior of economic agents who are modeled as only-occasionally-purposeful collections of lower-dimensional optimizations is far less straightforward than the neoclassic aggregation of agents each represented as a single full-dimension optimization. It may be, for example, that households' entertainment expenditures are believed to be price-inelastic, so that a broad-based entertainment tax may be viewed as generating revenue with limited distortions and less regressiveness than alternatives. Which prices and qualities are part of the optimization we choose as a limited-realism model of household entertainment expenditures may be quite different for households where entertainment consists almost exclusively of active involvements than for those whose entertainment expenditures are almost entirely passive or those with quite a mixture. It may only make sense to estimate distortions of an entertainment tax via separate aggregations over the three types of households.

5.2. History dependence

Without any diligent research, it is our impression that the organizational structure of most corporations is strongly affected by history. It may be that at Fifth Third bank, corporate real-estate finance is a subdivision of the mortgage-lending division because forty years ago it was but a miniscule part of the bank's business. Meanwhile, Sixth Fourth bank grew out of an entity that provided a variety of financial services to corporations, and only got into retail banking twenty years ago when a retail bank on the verge of bankruptcy was a ripe acquisition target. So at Sixth Fourth bank, corporate real-estate finance is an important subdivision of the corporate-relations division, and direct conversations between it and the mortgage lenders are never a scheduled occurrence. As a result, these two banks are likely to exhibit quite different reactions to new regulations restricting the securitization of corporate-real-estate bonds, as the dimensions in which each reacts to those regulations are a small-dimensional subset of each bank's concerns, and a distinct subset from that of the other bank. Furthermore, there may well be banks that react in an acceptance of the new regulations, and other (larger?) banks that react by lobbying to alter the

4 Nonetheless, problems of aggregating such models may be far less complicated than aggregating boundedly rational models.
regulations or be exempted from them. Clearly, this would call for separately aggregating predicted behavior of accepting banks from those not accepting.

5.3. Myopia

It is also critical to adapt analysis of the long-run impact of governmental policies and behaviors to the feature that firms and households who respond only within diminished dimensions are in an important sense short-sighted in their behavior, relative to neoclassic optimization. It may help to think of this as if the sort of indirect effects we are used to calling general-equilibrium effects are attenuated in two ways. First, households and firms are reacting separately to small-dimensional subsets of the set of prices that are changing, rather than to the entire vector of price changes, and in particular are apparently not anticipating that at some future time an exogenous occurrence will lead them to respond purposefully to the panoply of changes. Second, the sort of transitions assumed by dynamic-stochastic-general-equilibrium models (e.g., Algan, Allais and Den Haan, 2008) shall be vastly misleading in a world of diminished-dimensional responses. Such a world, also, could hardly be further from that posited in rational-expectations models (Lucas, 1972).

5.4. Neoclassically naive modeling

A model that is naïve by neoclassical standards may be a good predictor of policy impacts. This is far from a general statement, and usage of such models should be cautious. However, it is possible that for some policy issues partial-equilibrium models will have smaller prediction errors than general-equilibrium models. Models assuming a present bias or hyperbolic discounting (e.g., Laibson, 1997) may have smaller prediction errors than neoclassical models even if that sort of assumption is far from universally true. Models that assume many household decisions are driven by habit (e.g., Pollak, 1970), with habitual behaviors only reconsidered when found to be decidedly suboptimal, could offer substantial hope of predictive analysis.

5.5. Allowance for unattending

Theoretical regulatory economics made an advance toward realism when Laffont and Tirole (1984,1986) introduced a parameter for the efficiency costs of public funds when different regulatory mechanisms might imply different subsidies to or taxes on regulated firms; prior analyses had implicitly assumed availability of lump-sum tax revenue. In this spirit, a wide variety of political-economic analyses could include a parameter for the value of unattended variables, which may well render optimization models smaller gaps from realism. For example, a model of household responses to a series of modest monthly carbon-tax increases might have a parameter to represent the expected present value of the increase in consumer surplus that will result when an external shock causes the household to engage in a broad reexamination of its budgets. The parameter could reflect the difference in consumer surplus between a full-dimensional optimization and sets of optimizations within categories, and be influenced by (future) research into the frequency with which external shocks cause such reallocations across budgets.

6. Welfare Analysis

Clearly, a model of the entire economy is needed to understand welfare, or to understand a full cost-benefit analysis of a particular policy. However, the models one would hope to use don’t look at all like a neoclassical model. A method to aggregate efficiency information from a collection of diminished-dimensional responses is a critical need.

It may well be that experiments will have to play a key role. Experimental methodology to discern shortfalls from allocative efficiency has recently been developed for both laboratory and field studies.

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5 For more than a year, the few US banks that are huge spent in aggregate more than $1 million per day lobbying to have regulations undercut the Dodd-Frank Act (Warren, 2014).
(Harstad, 2014). However, the current methodology observes what are in essence short-term shortfalls, and considerably more elaborate techniques might be needed to observe shortfalls over the period of time relevant to assessing efficiency of long-term policy impacts.

7. Empirical Studies

Our focus has been on modeling issues. Reliable empirical analysis is closely tied to underlying models. Most empirical political-economy studies have in fact only included a small number of variables in various best-fit data analyses—including related prices of key substitutes and complements as explanatory variables, such as airfare, car rental and restaurant costs in estimating the effects of hotel occupancy taxes on volume of tourism business. There is no attempt to include prices of education, medical insurance, rental housing or a thousand other commodities. A study of the effects of reduced governmental support for higher education will attempt to include a perhaps a half-dozen other key variables thought to be important in the decisions of potential students whether to obtain more schooling or pursue employment with the level of schooling already attained.

Roughly speaking, then, most empirical studies are utilizing data as if the underlying decisions were diminished in dimensionality. Closer attention may still be warranted, however. The behavioral responses to policy changes we seek to predict come from economic entities that pay regular attention only to small-dimensional problems, and generally look more broadly into their behaviors only when confronted with what may loosely be regarded as exogenous shocks. These exogenous shocks may suggest that time-stamped data was drawn from a distribution with structural breaks. Where the structural break was a government shutdown or a typhoon, adjusting for it can be straightforward. Where the data include individual or lightly-aggregated behaviors, structural breaks may vary with the data source, as when various towns had a major employer arrive, go bankrupt or leave. In some cases, it may be possible for econometric tests to discover where the structural breaks are. Less disaggregated data may find these issues more problematic. In all these empirical studies, when the model treats the underlying behavior as classic optimization, the fact that this is not how economic agents behave should yield far more cautious conclusions than is the norm.

Important empirical regularities need to be understood in cases where scant data exist now. One important example is discussed above in section 5.5.

8. Ending Remarks

Essays like this shouldn't end with a drum roll and triumphal coda. A quiet hopeful eye toward what might transpire makes a lot more sense.

Dysfunctional government seems to be becoming the norm in far more places around the earth than in the last couple generations. The Samuelsonian dictum that no other discipline offers a good substitute for economic analysis is abated only by the extent to which disciplines adopt (at least partially) economists' methods. Yet in the way this essay has pointed to, economists' analyses tend to miss a critical aspect of the behavior of those impacted by governmental policies: the dimensional size of the problems they solve. This opens up a perhaps unprecedented range of opportunities—laid out above—to improve on the modeling used to generate economists' policy advice.

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6 We know almost nothing about the details of such testing.
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