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Macroeconomic Modeling in Less Developed Countries: Toward A Strategy for USAID

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I. SUMMARY AND INTRODUCTION

This paper discusses what sort of computable general equilibrium (henceforth CGE) model building it would be worthwhile for USAID to pursue as part of the policy advising process. It discusses the costs and benefits of alternative approaches and provides a readers' guide to some of the other literature. Many of the points to be made here are touched on briefly with the reader referred to other studies by myself and others which illustrate by example the points I feel are important.

To start, I believe the reader should look at Tower and Loo (1989). This paper was commissioned by USAID for a volume on tax reform edited by Malcolm Gillis. The paper is a statement on what USAID can get out of such models, and how it should use models and modelers in the policy advising process. It also summarizes work that I have done with others. While the volume in which it appears does not appear until May 1989, I have provided the mission with a copy of the paper. I do not duplicate this material in this essay.

Next, for a very simple example of the application of a CGE model to the problem of income distribution and efficiency, see Tower and Christiansen (1988)'s analysis of the Malawian fertilizer subsidy. In this paper, we present an intuitive discussion of how the model works. Then we present the results. Finally, in the appendices we present the mathematics, which is quite easy to follow, along with the actual "Lotus" spreadsheet. The software is available upon request.

Next, for an example of what I think is a superior alternative to DRCs, namely cost-benefit ratios for sectoral policy, both in the long and short run, which evaluate the efficiency and revenue implications of trade policy reform and government projects, I recommend Gan and Tower (1987)'s analysis of Malaysia. The mathematical model used there is not presented in the paper, but the paper does describe it verbally. This paper also teaches the meaning of the term "shadow price," how to use shadow prices correctly and how to calculate them.

For an example of the kind of analysis of incentive structure which applies to the sickest, most distorted type of economy that USAID is likely to deal with, the reader should turn to Han and Tower (1988)'s analysis of the Sudan. The Sudan exhibits a number of problems that USAID is frequently called upon to deal with.

Two other studies which are crystal clear and make points crisply that are crucial for sensible policy in less developed economies are Taylor-Black (1974) and de Melo (1978). I will be happy to furnish copies of these to interested people.

I. Summary

I tend not to like surveys of model building efforts in various areas, because they tend to be long on results and short on logic. A marked exception to this is Sherman Robinson's (1988) piece in the Handbook of Development Economics. It is an excellent piece, which effectively teaches much about CGEs and has a balanced and sensible perspective.

Anne Krueger states in her article in Jones and Kenen (1984) that less developed economies are qualitatively just like developed economies, except that the distortions they suffer from are much worse. Thus, the insights that emerge from modeling of developed countries apply in magnified terms to LDCs. My favorite easy-to-understand model of the welfare cost of tax collection in DCs which also applies to LDCs is Stuart (1984).

Several of these articles teach by example what CGEs can do. I believe that they serve as useful templates for the kind of analysis that USAID should perform regularly.

The major weakness of my articles cited above (which I intend to fix in future work) is (1) the absence of any treatment of rent seeking associated with minimum wages and licensing, particularly import licencing but more generally any kind of discretionary licencing, and (2) the existence of resource using tax evasion and smuggling activities. These are critically important issues in less developed countries, and a number of studies by John Whalley and others are nice applications of these ideas to less developed countries. A reading list is provided in Appendix 7. It is important for models to deal with these issues.

The most important points I wish to stress are the following:

1/ Simple models are cheapest, serve the teaching role most effectively, and have the highest product per dollar spent. Thus, USAID should commission the development of simple models by modelers who are conversant with recent ideas in policy reform and know the results and tools that other modelers are using. USAID personnel should be in on the development and analysis of the model. When you think you need a DRC do a simple model.

2/ Any model's results depend on the particular story told about how both the government and private sector respond to exogenous changes. Each simulation is like a Biblical Parable. It illustrates a point, but requires interpretation to make it provide guidance for dealing with current problems. Thus, I think it is worth presenting the results from the model, but these are only if -- then statements. They are to be used as

tools to perfect the intuition and make better guesses than would otherwise be available about how the economy would respond under other circumstances. For example a full employment model that predicts real wages will have to fall by x% implies that prices would have to rise by x% if full employment is to be maintained in a world where wages are inflexible downward. Similarly a model that predicts that y% of the labor force will have to move out of industry into other sectors when the economy is liberalized, will imply a maximum unemployment rate of y% on that account.

3/ Data limitations are no reason to shy away from model building. The most critical ingredients into model building exercises are the distortions in the economy (e.g.taxes and the tax equivalents of quotas) and an accurate qualitative appraisal of the forces at work (e.g. monopoly power, rent seeking, and how licenses are really allocated). Once these items are known, the appropriate directions for policy reform are not hard to figure out. Then knowing the elasticities of demand and supply and the social accounting matrix describing flows within the economy is needed to get a quantitative handle on the problem. But I would argue that a clear understanding of how the economy works, which involves interviews, especially with the private sector is the most critical ingredient. Data without interpretation is useless. My bete noir is Jansen's analysis of Sudan, which tells us about DRCs but not what is going on in the economy, e.g. are there property rights in agriculture?

4/ The CGE model is not a goal in itself. It only serves to quantify the gains from policy reform. The most persuasive tool is going to be common sense supported by a consensus of model builders' experience with simulations and a consensus of historical experience with the effects of tax reform, deregulation and trade policy reform. Thus, again the modeler needs to be familiar with economic common sense, the state of the art of model building and what recent economic history has to say. Good software and technical expertise in using it does not a competent modeler make.

5/ Often the most effective use of model building is to combat incorrect conventional wisdom held by policymakers or politically powerful individuals. Thus, the model building exercise should often be directed at debunking particularly silly ideas. Thus, the modeler needs to work closely with the policy advisor to discover what silly ideas the relevant actors hold.

6/ I believe that the current state of modeling is not good enough to use it to fine tune the economy by calculating optimum tax rates to any high degree of disaggregation. Two more good arguments against fine tuning, which emerge in Gillis (1989), are

that uniformity of taxes (mentioning no sector by name in the tax code) gives the private sector solace, because it guarantees entrepreneurs that they will not be singled out for abusive treatment as the political winds change, and because it is doubtful that considerations of efficiency would have much to do with the final set of differentiated taxes that would emerge from the political process. This latter argument is also made by Alfred Marshall who remarks (as quoted in Bhagwati [1988, p.31]) that "in becoming intricate [protection] became corrupt, and tended to corrupt general politics." For example, consider the extent to which U.S. industrial policy subsidizes losers like shoes and steel, and makes agriculture less efficient. Thus, I recommend using CGEs to obtain rough guesses of the benefits from moving from highly differentiated taxes and administrative allocations of goods and licenses to a uniform, low rate tax structure and letting the market rip. It also enables us to make statements like: "For every job you create in automobile assembly in your country it costs $200,000 annually in the standard of living."

7/ In connection with the fine tuning issue, Paul Krugman, Professor at MIT, and arguably the world's leading specialist in "strategic trade policy," i.e. discretionary trade restrictions, while he determines optimal trade interventions for a living, argues that free trade is the only sensible policy, given the way the political system works. Blinder (1987) makes the same point.

8/ Also, on the issue of fine tuning consider the fact mentioned by Stanley Fischer (1986) that no economist could have predicted the hub-and-spoke pattern of airline service that resulted from airline deregulation in the US. All economists could predict is that the deregulation would generate an increase in the net output from the airline sector, valued at the prices faced by the airline industry. Thus, there is a limit to the accuracy that we can expect from models' predictions.

9/ Finally, Harberger emphasizes that even very detailed models which have say 100 sectors will still aggregate all copper products (pennies, lamps and wires) into one, which are in reality quite different products. Also, accounting data, even in a country like the US does not reflect true economic cost. Finally, input-output flows reflect totals and input output coefficients reflect averages. Since marginal costs by those firms most likely to adjust output are the relevant items in policy decisions input output tables, even when carefully constructed are likely to be of limited usefulness in fine tuning. The same point applies to DRCs.

II. MODELING THE EFFECTS OF POLICY CHANGES ON EFFICIENCY AND INCOME DISTRIBUTION

My charge in this section is to briefly describe the various approaches possible, from the least complex to the most complex and then discuss the costs and benefits of the alternatives. I think the most effective way to do this is to consider good examples of the various approaches.

A. ALTERNATIVE APPROACHES

An absolutely first class discussion of alternative approaches to CGE modeling is Robinson (1988). The reader should read this article before proceeding further. Particularly useful is Robinson's distinction between analytic, stylized and applied models.

In what follows I will restrict myself to considering the types of modelling exercises that I think are useful for USAID. USAID has done relatively little modeling to date. Thus, there is scope for doing relatively simple modeling tasks first. I will cite several examples of what I consider to be useful examples of policy analysis.

1. Recording distortions

The first step in any modeling exercise is to record the distortions that exist in the economy. This includes taxes, the tax equivalents of quotas, the wedges between black market and official prices, waiting times for licenses, subsidies, gaps between borrowing and lending rates, and wedges between marketing board buying and selling prices. This part of the exercise gives the policy advisor a good idea of what is wrong with the economy. If one believes, as I do, that the best policy is to establish a set of roughly uniform, low rate taxes, this exercise in itself will tell what reforms are needed.

Secondly, any regulations in force which may be distorting should be recorded. For example, in Indonesia under the old regime in force before 1985, all import licenses were allocated to domestic producers of the importable good. In New Zealand in 1978 many firms were constrained to keep their prices low enough or their techniques of production inefficient enough so that they made no more than an after-tax 6.5% profit per year on the book value of their investment, which in the presence of inflation of 15%/year was devastating to investment incentives.

Third, any distortions due to misinformation (e.g. an inadequate appreciation of the productivity of fertilizer), missing markets (e.g. the inability to get credit) and lack of property rights (e.g. overfishing, overgrazing, and overcutting of timber) should be recorded.

If the government agrees to move to sensible taxes to keep up incentives and correct for externalities and to eliminate silly regulations, then there is no need to do further modelling. This is because one needs modelling (1) to convince government officials to change those things they are reluctant to change and (2) to deal with problems of the second best: namely if certain things in the economy which ideally should be changed can't be changed, what is the optimum level for those things which can be changed? In this latter situation it is impossible to correct the distortions at their source and one needs to look at the responsiveness of flows between sectors to devise optimal policy.

2. Aggregating distortions

Sometimes it is useful to aggregate distortions in certain ways. If one wants to make the point that resources are being systematically shunted out of the export sector into import-competing activity one would want to calculate the "bias against exports." If there is a uniform import tariff of 50% of the world price and a uniform export tariff of 33% of the domestic price, then the domestic relative price of exports will equal [1/((1.33)(1.5))=1/2=.5]times the world relative price of imports. This is equivalent to free trade on the import side combined with a 100% export tax (as a proportion of the domestic price). This is sometimes summarized as a bias against exports of 100%. Thus, the bias against exports is the implicit export tax. Its implication is that if markets are competitive, then at the margin a dollar's worth of resources in the export sector is earning twice as much foreign exchange as a dollar's worth of resources saves from being located in the import sector. For more on this see Tower (1984).

Now suppose we want to emphasize that the trade regime discriminates against some sectors and in favor of others. In this case we can calculate the income that primary factors in an industry receive and divide it by what income they would have received if the sector had transacted all inputs and outputs at world prices. The answer is what is known as the effective rate of protection coefficient. This is the effective rate of protection plus 1. Thus, the effective rate of protection can be thought as the implicit subsidy on value added in a sector generated by the foreign trade regime. The extent to which ERPs differ between sectors is a measure of the extent to which sectors are treated unevenly and consequently the extent to which resources are encouraged to move into sectors where at the margin there is no comparative advantage. This is discussed in more detail in Gan and Tower (1987) Loo and Tower (1989) and Tower (1986). To calculate the ERP coefficient we need to know the

input-output table. Often, however, one simply wants to make the point that sectors are being treated unevenly and that there are gains to be had from more uniform incentives. Such a point can easily be made by studying only the most egregious cases of uneven treatment.

Thus "bias" and the "ERP" are simply useful aggregates of distortions that enable one to think more clearly about the unevenness of incentives and the potential for efficiency gain from resource shifting at the margin. For example we can use these to say how much foreign exchange will be saved or earned per dollar of resources shifted from sector A to sector B by policies which move resources in that direction.

A concept similar to the "ERP" is the effective tax rate on investment financed in various ways developed by King and Fullerton and applied in King and Fullerton (1984). Their approach consists of looking at the wedge between private and social rates of return on investment financed in different ways (e.g. out of retained earnings, versus borrowing versus equity issue). The double taxation of dividends in the US, the interaction of the tax system with inflation, and the differentials between economic and accounting rates of depreciation for different types of investment means that effective tax rates on different types of investment activity vary widely, with the implication that investment is allocated inefficiently and that in times of inflation consumption will replace saving and investment.

These measures of incentives are fairly easy to calculate. They should be calculated prior to building CGEs, because (a) they are cheaper and (b) they are important to record in order to intuitively interpret the results of a CGE. For more on exactly how they ought to be calculated and on how to use them in interpreting the output of a CGE model see Gan and Tower (1986).

All of these measures are independent of elasticities, so they are less controversial than CGEs.

3. Using CGEs to Estimate The Effects of Incentives on Resource Movement, Income Distribution, Efficiency, and Welfare

If one is unsatisfied with knowing how much efficiency is generated i.e. how much the average standard of living changes by shifting a unit of resources from one sector to another and wants to know the effect of a policy reform which will shift many different resources between many different sectors and also cause consumption patterns to alter, one must build a CGE. This involves adding consumption elasticities to the model and postulating the extent to which factors will move between sectors

in response to changed incentives. Taylor and Black (1974) is a nice example of a simple exercise of this sort. Interestingly enough Taylor and Black chose to look solely at how changes in tariffs would shift resources, without looking at the effects on economic efficiency or income distribution. Ironically, it would have cost them nothing to solve for the latter two items, which seem to me to be the whole rationale for policy reform. After all, resource allocation is not the end goal of economic policy. Gan and Tower (1987) and Han and Tower (1988) are examples of attempts to calculate the right things using linearized models.

In constructing a model of this sort, one can focus on the short run, long run or permit resources to move gradually and trace out the dynamic path of the economy. It is important not to adjust incentives to maximize short run gains with no eye to the future. It is also important to consider the short run consequences of any adjustment of incentives designed to generate long run gains. Thus, I believe a useful compromise is to examine a short run solution in which little capital has been reallocated (this is Alfred Marshall's definition of the short run) and a long run solution in which all factors have been allocated so as to maximize their return.

Gan and Tower (1987) show how to perform the analysis both for the short run and for the long run in which capital is perfectly mobile between sectors. The path taken in that article was to assume all saving was done by foreigners. This greatly simplified the analysis. I am not familiar with alternatives that lend themselves to quick and easy solution.

4. Dynamic Models

The models suggested in the above section are a halfway house between ERP type incentive calculations and a full fledged dynamic model that attempts to describe the period to period evolution of the economy. The ideal may well be to simulate a dynamic model. Good examples are Kelley and Williamson (1984) and Adelman and Robinson (1978). One could then evaluate the desirability of alternative scenarios. This modelling requires more resources. One must also be careful that transparency is preserved. One Korean graduate student remarked to me that the Adelman-Robinson study had little impact on policy, because no one could understand the mechanisms at work. Also, a model like either one of these is likely to be driven strongly by savings rates in the economy. Their simulations are contingent on particular tax policies and consequently particular savings rates. If one believes that reasonably efficient taxes are available and are politically feasible to collect like taxes on fixed factors of production, or consumption- based value added taxes, which have limited distortionary impacts, (See Judd,

Journal of Political Economy, 1987, who argues that taxes on labor income have small distortionary effects.) then one can effectively describe the tradeoffs between alternative policies by asking, if it were desired to leave the total value of the capital formation unchanged via the simultaneous adjustment of taxes combined with government savings, how much foreign exchange could be saved or debt repaid by switching from one type of tax to another. This idea is that of Little-Mirrlees shadow pricing, discussed in Tower and Pursell (1987) Oxford Economic Papers. Such an approach can make an essentially dynamic problem amenable to solution by static tools.

I think that one can make a choice just by contrasting the simple models of Tower, de Melo (1978) and Taylor-Black (1974) with Adelman and Robinson (1978) and Kelley and Williamson (1984). The costs of building the dynamic models could best be assessed by the authors. My feeling is that it is important to keep in mind Robinson's (1988, section 2.3) discussion of analytic, stylized and applied models. As he notes there:

"Moving from analytic to stylized to applied models allows increased institutional specificity, as well as the inclusion of a wider range of economic phenomena. The tradeoff, of course, is that the additional detail and size may obscure the major causal mechanisms that drive the model, without adding any empirically significant effects. Since different types of models permit different insights, it is often desirable when analyzing various problems to move back and forth between analytic, stylized, and applied models. There are costs and benefits to operating at each level that must always be balanced, and it is generally true that the analysis of any particular problem will be improved by using more than one kind of model."

It is interesting to note that most of the pieces in Newbery and Stern (1987) do not deal with dynamic issues, although a few do. Yet if the issue is something like the role of financial repression in causing inadequate saving for old age, it is important to deal with savings and investment.

B. RELATIVE COSTS

1. Data and Time Required

It is easier to make mistakes with larger than with smaller models. The former also require more time to build, debug and calibrate. Models are most effective when they are produced when needed, which may make time critical. These are all obvious points. Again, I feel that the major role of modeling is to force the actors in the policy debate to think correctly about opportunity costs. The simplest model to do that is generally

the appropriate one to use. As soon as the debate turns to opportunity cost, then a reasonably sensible policy cannot be too far away. Much sensible policy analysis comes from two dimensional supply and demand curve analysis and from two dimensional production possibility frontier and indifference curve analysis. I visualize the most practically useful modeling for day to day policy analysis as stylized modeling that takes the degree of complexity only a few steps further than two dimensional classroom examples.

2. Costs of Solution and Types of Software

Types of software are mentioned in appendix 1.

One alternative is a spreadsheet for calculating linearized models. In effect one is taking a first order Taylor series approximation to the true change. This is usually sufficient to illustrate the concept of opportunity cost. Various spreadsheets are preferred by different individuals. "Lotus" is the one with which I am familiar, but my graduate student, Tom Loo prefers "Quatro," and some of my undergraduates prefer still another alternative, "Excell," noting that "Lotus sucks." Using these spreadsheets requires an understanding of matrix algebra. Programing them is tedious for large models. Thus, I expect spreadsheets are sensible only for models which have 5 sectors or less, as 5 sectors involve something like 40 equations.

An alternative, if one is satisfied with using linearized models is GEMPAK, which has been developed by a group at Melbourne and La Trobe Universities in Melbourne, Australia. All Australian modelers use this technique, although it is used only at one university in Canada and two universities in the US. It appears to be easier to use then GAMS but only marginally so. I will know more about the comparative user friendliness of the two by the end of April 1989, as my students will have had a chance to compare the two. For illustrations of the power of GEMPAK one should look at Dixon, Parmenter, Sutton and Vincent (1982).

The last alternative is GAMS, developed at the World Bank. As mentioned in appendix 8, one of my students was able to teach himself how to use it in a weekend, so that he could solve simple linearized models with it. One can use it either to solve both linearized and nonlinearized models. Thus, it is so flexible that investment in learning how to use it is probably a worthwhile investment for most modelers.

A useful software which analyzes optimum pricing problems in a multimarket agricultural sector has been developed by Braverman et al. and is discussed in chapter 17 of Newbery and Stern

(1987). Since this program is very user friendly, it probably makes sense for USAID to explore its usefulness.

It should be noted that the setup cost is the smallest for the first alternative in some circumstances, since only that one does not require a hard disk. Also, "Lotus" costs only $300, the Braverman program I believe is free, GEMPAK costs $2000 for the mainframe version, $1200 for the PC version, and $50 for a truncated demonstration version. I do not know the costs of GAMS, although many universities, Duke among them, have site licenses. It is also possible to solve nonlinear models with other programs. One of these is GAUSS, which is also available at most universities.

C. RELATIVE FLEXIBILITY

1. Introduction

There is something to be said for various different types of models. As discussed above different models are good for different things.

2. The Goals of Modeling

I believe that the major goal of building models is to convince policy makers and other relevant actors of the costs of policies that are harmful to efficiency and equity, i.e. those which benefit powerful special interests.

A second goal is to warn of ways that policies interact to yield results that might not look bad by themselves: for example the way in which import tariffs and export taxes reinforce one another, or the way in which low import tariffs on intermediate inputs used in import competing sectors combine with high import tariffs on final products to generate extraordinarily high effective rates of protection for import competing sectors.

Once the policy maker is able to qualitatively grasp the opportunity costs of the alternatives he faces, with some understanding of the rough magnitudes involved, he is unlikely to do anything egregiously foolish, like fostering hyperinflation, autarky, or extraordinarily wasteful consumption by highly subsidizing staples. To deal with these basket cases of perverse policy making a pretty simple approach should suffice.

Is it necessary to do a careful probability analysis of getting run over and to compare it with the value of time to convince a kid to look both ways before crossing the street?

As usual a balanced view comes from Robinson (1988, p.8):

"The policy conclusions that can be derived from analytic models tend to be general statements such as: 'free trade is good,' 'price distortions are bad and attempts to fix prices are terrible,' 'quantity restrictions on imports are worse than tariffs,' or 'do not ignore market mechanisms.' And even in these cases, there is an active industry among economists who delight in thinking up counterexamples. For similar reasons, a stylized numerical model can only rarely be used for policy analysis, since it is usually too simplified to capture the institutional and country detail required to provide good numerical estimates of the impact of various specific policies." Of course the dividing line between "stylized," and "applied" is not hard and fast.

3. The Issues

Most curable misery in less developed and other economies arises from major policy mistakes, or policies clearly designed to support something other than a high average standard of living. Look at Zambia, the U.S. Budget Deficit, Chilean labor market problems in the early 1980s, the LDC debt crisis, the US Farm Problem, VERs, LDC foreign exchange shortages, financial repression, import substitution, minimum wages, and controlled prices cum rent seeking.

What is needed to deal with these policies is to convince the policymaker and other influential individuals that these policies are either wrongheaded or serve special interests without fostering the general welfare.

In general USAID doesn't have the resources to do great research, and it should probably accept its role as economic educator and apologist for the general welfare, which means that relatively simple approaches should be used heavily.

4. Thoughts on Income Distribution

Just identifying the winners and losers from policy change isn't very interesting. The trick is to do the income distribution accounting in a way that drives an important message home. Here are examples of interesting things to do with income distribution calculations.

1. Fight vested interests' use of silly partial equilibrium analysis by stressing if there is no efficiency gain, any fattening of one group puts some other one on a diet.

2. Almost anything which makes capital better off in the short run, causes increased capital formation and in the long run

creates new jobs or better wages. There are exceptions, of course, like protecting capital intensive industry from foreign competition. But the statement is true of attempts to devalue import licenses by freeing up trade, and eliminating minimum wages, licenses for investment, and inefficient regulation.

3. Many policies which look appealing, because they make the currently employed better off in the short run, like a higher effective minimum wage, or penalties for sacking workers destroy attractive jobs or lower wages.

4. Lots of policies which make some workers better off in the short run by destroying competition in the labor market make other workers worse off, even in a fairly short run, by raising prices and throwing workers out of the protected sector into the unprotected sector and kicking down wages there.

5. Budget deficits which subsidize consumption of certain goods have got to restrict capital formation or result in increases in taxes on other goods. In the former case workers lose in the long haul. In the latter case the average standard of living will immediately decline, and workers may be worse off. In any case the net gain to workers is likely to be significantly less than the bread they consume multiplied by the price rise that didn't take place. Moreover, it may well be that the poorest folks consume dog food rather than bread anyway, in which case stabilizing the bread price in nominal terms may raise the price of dog food and be regressive within the lowest income classes. Moreover, it may well be the case that bread prices are effectively controlled only in the urban centers, with the poorest folks being in the hinterlands, in which case low bread prices stave off urban riots, but the policy may be inequitable. Moreover, such policies may reduce efficiency by creating an added incentive to move off the farm [already taxed to the hilt by a bias in the trade regime against agricultural exports] into import-competing manufacturing, which by shrinking the volume of trade, shrinks foreign exchange available and also shrinks taxes collected on the import and export sides, thereby creating a need for even more stringent import tariffs and higher taxes, both of which blunt efficiency and may move additional families into the aids ridden, subsidy ridden, and over crowded urban centers.

6. Attempts to create too equal an income distribution will cause emigration and raise the costs to multinational firms of locating footloose activities in the LDC. Here the relevant issue is the wedge between real incomes for comparable skill groups in the LDC and elsewhere.[2] For example, is it any wonder

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[2] I owe the first point to Harberger.

that much of the skilled labor force has left Sudan when in 1985 a bulldozer operator told me that he would multiply his wage by 14 in leaving Khartoum for the Persian Gulf.

5. Thoughts on Shadow Prices

As Tower and Pursell (1987), Gan and Tower (1987) and Han and Tower (1988) discuss: A shadow price of a good, factor, tax or policy or non-policy parameter is just the change in the economy's real income that results when the economy has one more unit of the good or the factor or the tax rises by 1% or the parameter rises by 1%, where the calculation takes into account the total adjustment of the economy to the change in question. Using these shadow prices one can figure out the contribution to national real income which would be made by a fall in oil prices, an increase in American VERs, a change in American aid, a change in the population growth rate, a steel mill which sucks iron and coal out of the economy and spits out steel, but which must be financed by an increase in the export tax on woven baskets. Several points need to be made.

1. Once a model is built it is little work to calculate shadow prices for all of the exogenously specified items in the model. The model can then be used for a myriad of purposes.

2. Shadow prices depend on the adjustment mechanism assumed, e.g. is payments balance accomplished by exchange rate adjustment or by changing quotas, and is the economy a full employment one, or do additional labor supplies or reduced aggregate demand cause unemployment. Consequently it is important to specify the model assumed when shadow prices are calculated, something that many studies do not do.

3. Shadow prices used to be used solely to evaluate projects. But an equally or perhaps more important use is to indicate how important it is to cut quotas, both at home and abroad, and how important it is to avoid investing in import-competing activities: see for example Gan and Tower (1987).

6. The Time Horizon

1. The idea is to model relevant opportunity costs - both intertemporal and intratemporal. Many taxes don't affect savings and investment significantly. Consequently, to analyze those a one period model is OK.

2. For tradeoffs between investment and consumption or unemployment and investment, or to evaluate policies which cause trade deficit today which mandates a trade surplus tomorrow,

intertemporal substitution is important. Thus, the relevant time horizon depends on the problem.

III. CHARACTERIZING GOOD MODELING

1. Introduction

Alan Blinder (1987, p.94) characterizes hard-headed economic policy:

"It should be based on facts. It should be based on logic rather than wishful thinking. And it should respect the laws of arithmetic. These requirements are not very constraining. They leave plenty of room for either ultraliberal or ultraconservative thinking. But they do insist on thinking."

Since economic modeling is designed to be the handmaiden of policy, exactly the same points characterize good modeling. Here are some further points to bear in mind.

2. Good modeling suggests and evaluates innovative approaches and options. It suggests pitfalls and demonstrates tradeoffs.

3. The Search of Uniqueness is Illusory

There is no one model. Different models will be relevant for different problems. Similarly, there is no one sensible specification. There is no one correct level of microeconomic rigor. You can either specify factor markets in detail and see what that implies about the aggregate responsiveness to changed incentives, or you can simply postulate an aggregate responsiveness of the economy that is consistent with your prior notions. In other words you can specify production functions and factor mobility or else you can just specify the reduced form of these relationships, i.e. the production possibility frontier.

4. Picking a Model

The recent intellectual macroeconomic history described in Blinder (1987) should be enough to convince one that there is no generally accepted model or set of parameters to describe economic adjustment in the short runs, so that there is no purely technical route to the truth. On the other hand, there are basic truths that economists of all political persuasions continually return to, driven by facts and logic. Modelers can build into their models rational expectations, Keynesian rigidities in adjustments and expectations, or Walrasian full employment. What one should pick depends on economic theory, econometric evidence and qualitative economic experience. Moreover, the same is true of long run adjustment. Twenty five years ago thinkers and modelers paid no attention to mechanisms that define a sensible economic thinker today: financial repression, rational expectations, rent seeking (which Blinder [1987] makes a cornerstone of his case for a market in pollution licenses), the theory of smuggling, the monetary approach to the balance of

payments, and the empirically estimated weaknesses of planning (except for perverse incentives producing perverse results in the Soviet Economy), or optimum tax theory (except for some rudimentary ideas like it is smart to tax fixed factors). Today these ideas are part of the foundation of all sensible modeling. Thus, models are a vehicle for introducing new ideas into policy discourse and assessing their importance.

5. On the Sequencing and Speed of Policy Change: Gradualism versus Cold Turkey

1. Mike Mussa (1986) makes a number of arguments for fast policy change, and others for slow policy change. In particular, he argues that if expectations are not formed correctly and are to some extent extrapolative or interpolative, it may be wise to either go slow, or perhaps overshoot the long run equilibrium, like subsidizing imports for a period during the move from tariffs to free trade. He also argues that income distributional effects of policy change are greater in the short run before factors have a chance to move far. He goes on to say, that if labor doesn't ever change jobs, but new entrants into the labor force come in to the sector where their prospects are best, it may be wise to liberalize the economy slowly, so that slight wage differentials move resources in the correct direction without creating outrageous wage differentials. To the extent that labor is only one of many inputs into production, this argument is weakened.

2. A counterbalancing argument is a political one: namely if a government decides on liberalization, but the next one may be tempted to reverse it and elections occur every N years, it is important to create a constituency for the liberalized economy and to have demonstrated the benefits of the liberalization by the time the new election taxes place, so a quick, well timed liberalization may be desirable.

3. Ed Leamer (1980) argues that a sequenced liberalization may be much less effective than a cold turkey liberalization if it discourages hard work and investment until after the entire liberalization has occurred and the economy is operating at maximum efficiency.

4. Expectations are important: if people think that liberalization may be reversed, they may postpone retraining themselves and moving to new job locations. Thus it may be critical for policymakers to move beyond the point of no return quickly in order to avoid "wait and see" unemployment.

5. Anne Krueger in discussing the South Korean experience with liberalization several years ago recalled that the shoe factories

when Korea was a relatively closed economy produced lousy quality stuff for the local market with inferior technology. When Korea opened up and Korea began to export, all of the old factories had to be scrapped and replaced with new ones which used new technology, required different skills and produced a new product. So even had the liberalization gone slow there would have still been discontinuous jumps in the economy. This also serves to debunk the infant industry argument for protection.

6. Parameter Estimates

Anybody new to the modeling business would be absolutely astounded how respectable it is, even among the most highly respected modelers, to pick reasonable guesses for parameter values out of the air. For example look at John Whalley (1985) or Deardorff and Stern (1986). Thus one need not be timid in selecting parameter values. Another trick one can use is to pick parameter values from some similar country in trying to model your special country. Also, one can pick plausible parameter values from either micro studies to describe structural equations on the micro level or macro studies to describe reduced form relationships on the macro level, e.g. the curvature of the production possibility frontier. The idea is not to pick the "right" values, since no one knows what they are, but rather to pick values which sensible people view as being reasonable. In my own work, I find I do a literature search to find out what the econometric evidence says and what other modelers have used. Then I do a great deal of telephone work, promising not to quote the person on the other end of the line if she will give me a plausible parameter value or tell me whether the one I was planning to use is too high or too low.

7. The Interpretation of Results and Debugging the Model

The process of building and debugging models is described in Tower and Loo (1989), so we summarize here. To develop the intuition and mathematical sophistication to solve a set of analytical models which are special cases of the ones that are typically built in international and development economics, one should master the mathematical appendices of Caves and Jones (1985), although this material is tough going.

When I build a model, I always do it generally, so that I can plug in special cases for parameter, both in order to apply it to other countries and to do sensitivity tests, for the country in question, and because one cheap way of simulating different time horizons is to use larger elasticities for the long run. But a major reason for approaching the problem this way is to enable me to run the model for special cases that I can intuit. For example, if one factor is immobile between sectors

and all production functions are fixed proportions, no perturbation of the model will cause any production to change. Similarly, if there are no distortions or externalities in the model, any small tax or tariff change will have no impact on economic welfare, since the Harberger deadweight loss triangle is a second order term, and in this distortionless world, the shadow price of every good and commodity is its market price.

An additional insight useful in debugging is the mathematics presented in Dixit (1987), a special case of which appears in "A Quick and Dirty Approach to Policy Evaluation in LDC's," which is one of the chapters in Tower (1984). This mathematics states that in response to a disturbance of some sort, the change in real income of the economy is equal to the values of the goods and factors which cross distortions [defined here as tax wedges plus externalities] multiplied by the size of the distortion plus the market value of any increase in endowment of goods and factors. A special case of this analysis is presented in one of the appendices of Loo and Tower (1989). The reason it is handy in the debugging is that it consists of an equation which is not used in the building of the model, so it is an independent check. This particular equation is also of great help in intuitively interpreting complex models with many distortions. One can use this equation to describe where the welfare gains and losses are coming from. While this paragraph will make little sense to the uninitiated reader, it is quite easy to master from Tower (1984).

8. Sensitivity Tests

Since so much of parameter selection is arbitrary, the first question people typically ask of the modeler is "How sensitive are your results to the parameters assumed?." Some results will be particularly sensitive. For example if a tax or tariff is initially slightly below the maximum revenue level, a slight change in the elasticities assumed may turn the conclusion that an increase in the tax raises revenue into the conclusion that it decreases revenue. However, typically no plausible change in parameter values will turn the conclusion that a hike in the tax reduces welfare to the conclusion that it increases it. Thus, in this case the appropriate interpretation (given uncertainty as to the true parameter value) is that the initial tariff is close to the maximum revenue level.

It is important that the modeler intuitively understand how changing the values for the important parameters will qualitatively change the results, and for her to check her intuition against the model, perhaps modifying both in the process.

One question is how big is the parameter range for which I produce results. I think the important idea here is to present results for your best guess about all parameter values over a short time horizon (2 years is probably sufficiently long for markets to clear) and for a longer run time horizon (8 years is short enough so that the basic structure of the economy can be thought of as remaining in tact, yet it is still of policy relevance). These central cases can be analyzed in the text. Then in the appendices one can present results for special values. However, perhaps an even better scheme is to always provide well documented software for any model one builds free of charge to readers, so they can discover for themselves how robust the model is, and explore its implications for issues that the modeler did not stress.

IV. AN APPLICATION OF THE APPROACH: MODELING POLICY REFORM IN BURUNDI - A PROPOSAL

1. What follows is based on discussion with Ben Severn and the reading of two documents:
"An Analysis of Agricultural Structural Adjustment in Burundi," James Bucknall, May 24, 1988 and
"Report and Recommendation of the President of the International Development Association to the Executive Directors on a Proposed Development Credit of SDR Million to the Republic of Burundi for a Second Structural Adjustment Program," April 8, 1988.

2. The following issues seem to be important ones in Burundi:
a./ Agricultural input and output pricing.(according to point 25 of the World Bank Document, the producer price share of world prices are 70% for coffee and 51 percent for tea)[3]
b./ The taxation of guest worker incomes (point 70, p. 20 of World Bank document).
c./ Import quotas on luxury goods (point 36)
d./ Protection of certain sectors of domestic industry (points 21 & 36)
e./ The costs of infant industry protection options through both temporary restrictions on imports of final products and temporary reductions in custom duties on intermediate goods. (point 22).
f./ Improving the efficiency of the drawback system (point 37)
g./ The effects of the current system of import tariffs ranging from 15-45%, with 100% import tariffs on luxury goods.
h./ The benefits of broadening the transaction tax base (point 33).
i./ The importance of trimming public expenditures (point 38).

3. I see a computer modeling exercise as demonstrating the gains in economic efficiency that would result from improvements in all of the above areas. My hunch is that in most instances the rural sector would be made better off while the urban sector would gain little by policy reforms. Thus, we would wish to talk about policy baskets which distribute the gains broadly, like moving from the existing system to a broadly based set of taxes which leaves the urban sector no worse off. We should also note

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[3] See point 59, p.17 of the World Bank report. I think that the "agricultural comparative advantage study" advocated here is silly. At the margin farmers will be producing all crops until their marginal costs are equal to the prices they face. Consequently, the important thing is to bring domestic relative prices in line with world relative prices (except for coffee which is subject to a quota imposed by the International Coffee Organization). Thus, I think it makes more sense to do an "incentive" study and to examine the consequences for both revenue and income distribution of alternative pricing policies.

that in the long run internal migration and capital formation will serve to distribute the benefits of any efficiency-improving policy broadly throughout the entire economy.

4. I see a study of this sort as consisting of a series of short (2-5 page double spaced) essays on each of these issues, explaining what the problems are and why the gains from improved policymaking arise.

5. This should be followed up by a the development of a model that includes the major agricultural sectors (perhaps 5), services, transport, ordinary industry and protected industry. The presence of smuggling, rent seeking and tax evasion would play roles in the model. We might wish to include three different consumer groups: rural, urban rich, and urban poor. These different groups would have different sources of income and expenditure patterns. As part of this model it would be necessary to develop a social accounting matrix, which would include an input-output model for the economy. To do this Burundian data as well as data from comparable economies would be used.

6. We would calculate cost benefit ratios like those in the Sudan, Malaysia and Malawi papers. In particular, we would emphasize:

a/ The high cost of using tax increases (except on coffee whose exports are limited by an international agreement) to collect government revenue, and consequently the benefits of trimming government expenditure. We would calculate the marginal welfare cost of a proportional increase in all taxes as well as the marginal welfare cost of increasing particular taxes, like those on international transactions.

b/ The extraordinary bias that exists against exports. The current system of roughly an average 45% import tax on industrial goods combined with a roughly 35% export tax on agriculture means that the domestic price of agricultural goods relative to industrial goods is .65/1.35=.48=48% of the world price ratio. This means that in effect the trade regime taxes exports at more than 100% of the domestic price. The point is that the import tax combined with the export tax teams up to create an extraordinary bias against exports. This is the Lerner symmetry theorem.

c/ We would examine the income distributional and efficiency aspects of changing the tax on guest workers.

d/ We would examine the effects on other sectors of reducing the special treatment to particular industries.

e/ We would emphasize the increased incentive to smuggle and the resources used up thereby when agricultural taxes and import tariffs get too high.

f/ We would stress the benefits of moving to a uniform value added tax.

g/ We would assess the benefits of moving to uniform pricing of agricultural goods.

h/ Two models would be built: one with a 2 year time horizon and one with a 10 year time horizon. The major differences between the two would be that in the latter formulation capital formation would play a larger role and the supply responses would be greater.

i/ Whether a linearized or non-linear approach would be used is immaterial. I suspect that eventually the nonlinear approach is going to dominate in this kind of model building.

j/ Here is one possible time table for the modeling exercise: Ed Tower spends a week and a half at Duke writing up a preliminary version of the model, a series of short issues papers and maps out what he thinks the final version of the paper will look like. Robert Slonim, a U. Cal. Berkeley BA, who is our best first year graduate student in economics at Duke (as measured by performance in my introductory graduate microeconomics course) and has traveled extensively in Africa, spends two weeks in Burundi, beginning around May 24 developing the model and gathering data. He then is joined in Nairobi by Ed Tower and Ed Yurcisin, Duke Undergraduate who has mastered GAMS to some degree. The three of them in consultation with REDSO develop and solve the model. At the end of two weeks, a model has been built, solved and a paper written. Tower leaves. Slonim and Yurcisin stay on until August 15, to teach GAMS and model building to REDSO personnel and work on other USAID projects. At the end of this period, some USAID personnel should be able to build models and solve them using GAMS. A number of others should understand enough of the strategy and nuts and bolts of model building to be able to use modelers effectively. Slonim could then finish off his PhD thesis by completing one other project of roughly the same complexity for USAID by June of 1990 and a final one by December of 1990. He would spend a major part of this time in Nairobi, both building models and instructing on the use of them.

k/ In a modeling project like this one, one feeds in information on the initial flows in the economy, like employment, legal trade, illegal trade and the taxes collected on each type of transaction. Then one feeds in the equations that describe the system. Next one feeds in the parameter values that characterize the system. Finally one feeds in new information, like the new level of foreign aid flows, oil prices or tax rates. One then runs the model to see what the economy looks like after these policy changes and exogenous non-policy changes have occurred.

APPENDIX 1
BUILDING PROTOTYPE MODELS FOR ECONOMIC POLICY REFORM IN EAST AFRICA: A PROPOSAL TO USAID
February 13, 1989

1. Purpose

My understanding is that USAID wishes to put more economic content into its policy dialogue with East African countries. This encompasses striving to improve USAID's understanding of the issues involved and to communicate this understanding more effectively. My belief is that this can be most effectively be accomplished by a series of clearly written short (2-5 page) memos which lay out the analysis. As part of these papers it is useful to have measures of the consequences of alternative policy reforms, particularly those for economic efficiency and income distribution. These measures can be derived in technical appendices which require explicit model building. Different issues will require different models. Thus, a series of models should be built to handle different issues which crop up with high frequency. What follows is my proposal for a series of policy essays accompanied by model building, which would be useful in themselves and would also be useful as prototypes for other analyses in East African countries and elsewhere.

2. Some issues which might be worth studying: Summary

a. A simple multi-country first pass at protectionism;
b. A cost-benefit analysis of protectionism for Kenya;
c. A cost-benefit analysis of the Somalian multiple exchange rate regime;
d. A cost-benefit analysis of Ugandan hyperinflation and financial repression.

3. Protectionism in East African Countries: Import Taxes, export taxes and import licencing

I think trade policy issues do lend themselves to a generic analysis that transcends many countries, more than most issues. Tom Loo, a Duke graduate student, and I built a model a year ago to look at the effects on less developed economies of agricultural liberalization by the developed world. There were 4 sectors: services, agriculture, mining and industry. Labor moved with some freedom between the various sectors. There was no unemployment. We used the same model structure for all the LDCs of the world and plugged in parameter values for particular countries. Tom Loo is currently reworking the model for his PhD thesis at Duke to analyze the effects of trade policy liberalization. Trade policy liberalization encompasses the reduction of export taxes, the switching from import licencing to import tariffs, and the reduction of import tariffs. He had planned to use the same aggregates of six different country types

that we had used before: (those which are contained in the World Bank's World Development Report) Low income, India, Lower Middle Income, Upper middle income, oil exporters, and highly indebted countries. We could do the same thing for East African Countries. Data would come from the WDR and best guesses by experts.

The story we would tell is the following:
(a) Switching from import licenses to tariffs reduces costly rent seeking. It also collects additional government revenue. Consequently, distorting taxes elsewhere in the system can be reduced, resulting in welfare improvements both due to the reduced rent seeking in itself and the greater efficiency of the lower tax rates.
(b) Lowering import tariffs moves resources out of import-competing industry into exportable agriculture. Since industry is subsidized to begin with and agriculture is taxed, an immediate efficiency gain results on the production side. Since the consumer price of industrial goods relative to agricultural goods prices is greater than the corresponding world relative price ratio, there will be consumption gains. Since exports and imports will both rise there should be an increase in trade tax revenues which should partially compensate for the reduced import tax rates, particularly in the longer run when domestic supply elasticities are higher.
(c) Lowering export taxes has a similar effect.

4. A cost-benefit analysis of protectionism in Kenya:

In this study we would take advantage of any information on input-output and social accounting matrices for Kenya to assess the efficiency and income distribution effects of altered protection in the Kenyan economy. We would work with a maximum of 6 sectors, 3 types of labor, 2 types of land and capital which is intersectorally immobile in the short run and intersectorally mobile in the long run. We would assess the impacts on welfare of the various actors and economic efficiency of changes in particular tariffs and quotas as well as proportional reductions in trade barriers. We would disaggregate no more than makes sense for the purposes of dialogue. We would also attempt to model whatever distortions in the labor market are felt to apply by experts on the Kenyan economy.

5. A cost-benefit analysis of the Somalian multiple exchange rate regime

Kiyoun Han and I have already performed an analysis of this problem for Sudan. In the proposed project, we would taylor the analysis to the particular institutional and economic

circumstances of Somalia. As in Sudan we would assess the efficiency and income distributional effects. The assumption one makes about the fiscal policies which accompany exchange-rate unification is a critical determinant of the outcome. For example if the multiple exchange rate is used as a revenue raising device, eliminating it without accompanying revenue-raising or government-expenditure reducing measures would put pressure on the government to raise the rate of monetary growth. If inflation is already above the revenue maximizing level, this would lead to ever increasing inflation and monetary collapse. On the other hand, exchange rate unification could lead to such an increase in economic activity that with existing tax rates the government could grow its way out of the deficit as the US hopes to do. Similarly, if the current multiple exchange regime generates little revenue, there would be no ill fiscal consequences. Finally, we could calculate whether exchange rate unification would increase or decrease the rate of inflation needed to balance the budget using the inflation tax.

6. A cost-benefit analysis of the Ugandan hyperinflation

Uganda has been increasing the money supply to finance government expenditure. The current inflation rate is high. I presume that Uganda has been keeping real interest rates to lenders and preferred borrowers negative. The inflation tax is in effect a tax on the saving and investment process as well as consumers who hold money prior to making consumption expenditures. We need to examine the effects of switching from the inflation tax to other more sensible taxes, and of eliminating artificially low real interest rates. We also need to look at the last Ugandan Shilling spent really costs the economy, recognizing that it increases the rate of inflation and the degree of financial repression in the economy. I predict this marginal welfare cost of taxation would be huge, and publicizing it would support attempts to shrink wasteful government expenditure and find more effective alternative taxes.

7. Linearized or nonlinear models

I have not personally had experience using GAMS to solve nonlinear models, because I have not felt the need to analyze large changes. For one thing the analysis of large changes involves more information than does the analysis of small changes. The solution technique I am familiar with is to linearize models and solve them using one of the two spreadsheet programs: "Lotus" or "Quatro." GAMS requires a computer with a hard disk to solve, and some models do not converge easily using GAMS. I can invert matrices up to 90 by 90 using "Lotus" on my Zenith 181 Laptop battery powered computer, which fits into my

briefcase. Thus, I can quickly solve small models using Lotus. Larger models can also be solved using "Lotus" by "backsolving." This technique involves combining equations to get the total number of variables down to 90, solving the model, and then calculating the remaining variables. Yoon Lee tells me that other techniques are also available. More complex models, like the proposed Kenyan one require more programming, and it would make more sense to solve those using either GAMS or else GEMPAK, which is a program developed by Ken Pearson at La Trobe University in Melbourne, Australia to simplify the programming of linearized models. This technique has been used in the development of the Orani model of the Australian economy at the University of Melbourne and the Industries Assistance Commission. Thus, it is a software which is used by a significant group of model builders, and is particularly easy to use. The logic of its use is identical to the logic of the way I use "Lotus". I would like to have the freedom to use whichever technique seems to best fit the problem at hand, and the amount of time I have to deal with computational issues, rather than commit to a particular computational technique at the present time. It would be desirable to solve a prototype model, like the Malawi fertilizer model using all three techniques, so that the costs and benefits of the three alternatives become readily apparent.

It should be noted that I can use "Lotus" to calculate the effects of policy changes to any desired degree of accuracy. This is because my "Lotus" approach is as follows. I read in parameter set A, which consists of exogenously set parameters like elasticities and factor shares. From these the computer uses identities like the national income identity and the fact that the factor shares in any production process must sum to unity to calculate a set of parameter values B which describes an internally consistent base equilibrium. The program then uses A and B to calculate coefficient matrices, C, and the changes in endogenous-variable values generated by changes in exogenous variable values. These new values can then be used to "update" the initial parameter set A, which is used to calculate B and C and hence newly updated parameters A and so forth. Thus, for example we can evaluate a 50 percent change in a tariff as the sum of 5 10 percent changes. While, I have not actually done this updating, at the worst one would have to do some hand work, and Tom Loo assures me that the programming is a piece of cake. Also, Ken Person has already dealt with this problem in the newest version of GEMPAK, although he says that this modification is not user friendly.

In view of the simpler computational requirements of the GEMPAK program, it might be more effective to use that program than GAMS for big models. A site licence can be purchased for

$500. However, the requirements of "Lotus" are so small, that I believe that is the natural place for modelers to start. I am currently teaching an advanced undergraduate and Master's level course at Duke in developing models for use in analyzing issues in international trade and development. The emphasis is in translating verbal statements of how economies work into mathematics and then using "Lotus" to derive policy implications. Students have much more trouble with the economics than they do with the computational problems. I suspect that it would be very easy to teach all economists at USAID what the potential use of these models are. Only those who have the ability to write out a consistent set of equations which describe an economy and have some experience in model building strategy are going to find that they can use any of these modeling techniques without help on the particular problem they are solving. This group can learn "Lotus" in half a day of instruction and half a day of practice. I can provide the problem sets which I am developing at Duke this semester along with answers by my best students to help USAID master "Lotus" in some plausible applications.

7. Personnel.

While I am capable of programming "Lotus" as I proved in Malawi, where I programmed the calculations for Bob Christiansen's and my paper on the Malawian Fertilizer Subsidy, I am slow at programming, and it would be cost effective for me to have help, my current or former graduate students or undergraduates, colleagues or USAID personnel. My favorite solution would be to have a computer whiz in Africa with me, who could both do the computer programming and teach others in USAID how to work with the computer, and could finish up work on the project after I leave. I would be able to spend a maximum of 1 month on the project in May or June, until the fall of 1989 when I could spend an additional 2 weeks.

If I were to offer a course in CGE modeling, I would want to offer it in conjunction with a computer whiz, like a graduate student. This would allow me to focus on economics and general strategy, and the graduate student who would be more adept at tricks for quick programing would be able to be a better and cheaper job on giving advice for quick mastery of the computational problems, and could also devote attention to working with students on debugging their models.

8. Agricultural Pricing Problems

Avishay Braverman and others at the World Bank have developed user friendly software to assess the effects on rural income distribution, prices and consumption of changes in prices

for agricultural inputs (e.g. fertilizer) and outputs. The technique is a linear calculation. They use AIDS (almost ideal demand system) demand functions and translog production functions, but these functional relationships permit their linear approach to yield precise answers even for large changes in exogenous parameters in certain circumstances. Any agricultural pricing problem should initially be dealt with using this software, I believe. While Braverman has sent a copy of his software to Tom Loo and myself at Duke, I have not had experience with it although Tom Loo has. If there is an interesting agricultural pricing problem to be dealt with, I think it would be worthwhile to apply his tools. However, unless the problem is an important one, it is not worth doing just to see how the tools work, because his tools have already been applied to several less developed countries. For the Korean application see Braverman, Hammer and Ahn (1987).

9. Selecting the Projects to Work On

It would be possible to myself and a computer whiz to produce prototype calculations for the four papers mentioned in section 2 and the one paper in section 8 in a four week period. These could then be refined over 2 additional months by the computer whiz along with one other person. My preference would be to select from this list two projects to work on in some detail during my one month in Kenya in May or June, with the intention that we have finished products at the end of that period. In addition, I could discuss with my coworkers the strategy for working on the three other projects, but the responsibility for competing them would fall on them during their remaining 2 months in Nairobi.

APPENDIX 2
PARTIAL EQUILIBRIUM VERSUS GENERAL EQUILIBRIUM AND THE ROLE OF MACROECONOMIC MODELING IN SECTORAL ANALYSIS

In assessing the effects on income distribution of sectoral policy (e.g. price control, value added taxation, tariffs and quotas), we need to postulate how changes in pricing policy affect revenues and foreign exchange availability and then work out the consequences of these imbalances under plausible assumptions about how the government deals with them: does it auction off the extra foreign exchange, liberalize quotas or adjust tariffs? How does the government deal with an increase in tax revenues? Does it stop printing the money so fast? Does it move from tariffs to given away import licenses? All this is to say that the income distributional consequences of sectoral policy will depend on the macro environment and how the government responds to changes. Thus, if one is to do a full fledged income distributional analysis, one needs to imbed the model of the sectors directly involved by the policy change in an overall macro model of the economy, which may be a very rudimentary model. Thus I have no problem focussing on sectoral issues, but I do think that it is important to work out the implications for reform in one sector for what is going on in other sectors, and that requires macro modeling. As an example of modeling a particular sector see Han's and my model of the wheat sector in Sudan. In fact I am not particularly proud of the detailed modeling of this sector in our paper, but given our knowledge about how the wheat sector worked we couldn't do any better. For modeling particular sectors and for selecting a plausible macro model to use in conjunction with our sectoral model, I would rely strongly on the views of people in USAID about how the economy being modeled works. My suspicion is that USAID has strong opinions about the links in East African economies, and I see the model builder's role as helping USAID refine its perceptions of these links and then working out the quantitative implications of those links that we agree are the relevant ones. I view the process of model building as being very closely tied to the policy advising process.

I understand that USAID is also interested in discussions of partial equilibrium approaches. If one is only interested in what happens to those in the sector in question, a partial equilibrium approach is perfectly adequate to deal with the problem. In fact the computer program developed by Hammer and Braverman at the World Bank may be all you need. However, if you are interested in knowing how an import tariff on machinery affects exports of agricultural goods or inflation you need a general equilibrium model.

If one is interested in how a particular tax or tariff or price change effects economic welfare, one is justified in using simple consumer and producer surplus analysis in a partial

equilibrium framework, so long as the rest of the economy is undistorted, which means no significant externalities, taxes tariffs or goods whose international prices depend on the levels of exports. To the extent that these assumptions are violated one must look at the interrelationships between markets, and attempt to capture the most important of these in a general equilibrium model. How one will want to model the problem will depend to some extent on the problem at hand. This is not to say that partial equilibrium analysis is not useful. It is always a useful input into the general equilibrium analysis. In order to figure out how a particular sectoral policy effects the economy it is important to have an accurate microeconomic view of how that sector operates, and sometimes these microeconomic analyses are referred to as partial equilibrium analyses. In this sense partial equilibrium analysis is an essential input into general equilibrium analysis, just as the whole is equal to the sum of its parts.

I think the issue of partial equilibrium versus general equilibrium modeling is very important, but I don't view it as supply and demand curves versus computer models. Any model necessarily leaves something out. The simpler it is, the more partial it is, and the trick for the modeler is to select the optimum point on the tradeoff between simplicity and complexity. My preference is for models which are simple enough to be readily understood and cheap to put together, but complex enough to give policy advisors an estimate of the consequences for aspects of the economy that concern them. As Paul Samuelson remarks there is no hard and fast dividing line between partial and general equilibrium models, because any partial equilibrium model is a general equilibrium model for specific sets of parameter values. For example, one can postulate a stationary demand curve when the marginal propensity to consume the good out of income is zero, and the prices of all other goods are held constant by free international trade.

Typically the term partial equilibrium analysis is used pejoratively. If I want to insult your model I call it "partial equilibrium." By this I mean you left something important out of the analysis or you forgot some important consequence. In this sense we would not want to do partial equilibrium analysis, whereas in the sense of the above paragraph, it is a fact of life. Thus, what I believe the "scope of work" has in mind is the identification of the "optimum degree of complexity." An example of bad partial equilibrium analysis is the following: "Keeping the price of diesel fuel down in Sudan will fight inflation." This is partial because it forgets that consequently the Sudanese budget deficit will worsen and the Sudanese will resort to increasing their money stock more rapidly than before,

which will result in a continuing rise in the price level, rather than just a once-and-for-all jump. Alternatively they will be forced to spend less on education or on roads each period which will shift inward the production possibility frontier each period, and with each period the same amount of money chasing fewer goods than before, continuing inflation is the necessary consequence.

APPENDIX 3
COMMENTS ON J. PRICE GITTINGER'S ANALYSIS OF DRCs IN HIS ECONOMIC ANALYSIS OF AGRICULTURAL PROJECTS

The author's description of the DRC as (p.398) "the cost in the domestic currency required to earn a unit of foreign exchange through a proposed project" is useful. I have no problem with thinking of the DRC as doing this.

I do have trouble, however, with the implicit idea that the shadow price of foreign exchange is the appropriate rate at which to convert the market prices of nontraded goods and factors of production into foreign exchange terms, for three reasons.

* First, the ratio of shadow prices to market prices for domestic factors of production may vary widely. In this case it is not legitimate to lump all domestic factors together as one in calculating DRCs. In the Sudan paper, for example, Han and I found these ratios to vary considerably. For example the ratio for wheat land was .25. For Rural labor it was 2.04. For urban labor it was .82. For capital in industry it was .18. Moreover, it varied extraordinarily depending on how the model was closed. For example, the shadow price ratio for rural labor varied between .24 and 66.5 depending on how the government balanced its budget. The low number was when the government varied its industrial import tariff. The high number was when the government varied the free exchange rate. For a full understanding of what this all means it is probably necessary to read the Sudan paper.

* Second, the shadow price of foreign exchange in utility numeraire is what people generally mean when they refer to the shadow price of foreign exchange. It is the increased value of consumption at initial consumer prices which having an extra unit of foreign exchange makes possible for the economy. Obviously, the shadow price of foreign exchange depends on how the incremental foreign exchange is made available to the private sector. Is it made available through a lump sum subsidy, a cut in the value added tax, a cut in the import tariff, a cut in the export tax, or a devaluation which assures that the extra foreign exchange is used up? Is this an important issue? Yes, I argue, because the ratio of the shadow price of foreign exchange to its market value varied from .57 to 158.5 depending on the closure rule used in the Sudan paper.

* Third, the ideal DRC has domestic resources evaluated at their shadow prices in the numerator and foreign exchange evaluated at its shadow price in the denominator. Thus, even if all domestic resources have roughly the same shadow price, unless their shadow price is unity, using just the shadow price of foreign exchange is going to give you the wrong answer.

Finally, the ideal DRC as calculated in the ideal way, which would specify the closure mechanism consistently gives you the answer to the following question: Suppose the sector in question is a small one, in the sense that to obliterate the sector would not change shadow prices of factors in the economy significantly. Suppose also that the sector is a competitive one so that profits in the sector have all been competed away. How much economic welfare does the economy lose if the government were to outlaw the industry. The answer is the economy looses the shadow value of the net output [say the steel produced] but gains the shadow value of the resources no longer used [say labor]. Thus the change in welfare can be written as minus shadow value of the steel plus the shadow value of the labor = [the shadow value of the steel]x[-1+DRC], where DRC is the ratio of the shadow value of the labor employed in the sector to the shadow value of the sector's output. Thus, there will be a net gain from obliterating the sector if and only if DRC>1. However, this interpretation depends crucially on the assumption that the industry is a small one in the sense discussed above. Thus, if there are factors that are not readily mobile into other sectors, this concept of the DRC breaks down. I have devoted more attention to this issue in Tower (1988). In that paper, I have also discussed other ways of interpreting the DRC and other ways of calculating shadow prices under alternative assumptions about adjustment mechanisms.

Conclusion:

Thus, I would recommend not bothering with shadow prices at all and recommend just looking at the ratios of domestic factors of production used in the sector divided by the net foreign exchange saved or earned in that sector, and treat that as the measure of the efficiency of the sector in converting domestic resources into foreign exchange, even though this particular measure would not measure the change in economic welfare per unit expansion or contraction of the industry, except in extraordinary circumstances. For incremental cost-benefit ratios, it is best to use one or several explicit cost/benefit ratio, like the ones Han and I calculated for Sudan.

APPENDIX 4

COMMENTS ON DORIS J. JANSEN AND MICHAEL V. SELHORST: "PRELIMINARY PROTECTION AND EFFICIENCY INDICATORS FOR THE KENYAN MANUFACTURING SECTOR," DRAFT REPORT, NOVEMBER 1985

1. Page 1-5: The authors write "If...policies have resulted in costs being higher in market than in economic prices, the policies have had a disincentive effect. The net effect of all policies can be measured by comparing profits measured in economic prices with profits measured in market prices."

This statement is incorrect, for several reasons:

a. The level of economic prices depends on what is used as numeraire. The two standard numeraires are utility and foreign exchange, and both may give different answers.

b. Shadow prices are generally taken to be second best shadow prices, and these answer the following question: what is the effect (on either welfare or foreign exchange savings) of the government's dropping one more widget into the economy? Answer: the shadow price of a widget. It does not show the effect of moving to neutral economic policies.

c. Profits at shadow prices of an industry that is competitive and operating with constant returns to scale will always be equal to zero. Why? The profits at market prices of such an industry will always equal zero. Suppose the government were to buy up all of the inputs in such an industry and produce itself using the same technology as the private sector. Then nothing would happen. The government would simply be doing what the private sector was doing previously. This means that the shadow price of the industry's inputs equals the shadow price of the industry's output. In other words, the profits of the industry at shadow prices equals zero. This argument is due to Diamond and Mirrlees (1976).

The above discussion assumes that by shadow price we mean second best shadow price. There is another concept of shadow price: the first best shadow price. The first best shadow price is (assuming fixed world prices, no externalities and the availability of lump sum taxes) the set of prices that would prevail in the absence of nonneutral taxes.

Suppose we replace the existing system of taxes, subsidies, tariffs and quotas with a neutral system of taxes. It is not true that the industries whose output prices have risen will also find that output will expand. The reason is that input prices will rise as well to create zero profit, and we do not know whether the zero profit condition will arise at an increased or a decreased level of output.

I conclude that the correct way to calculate the answer to the question posed: namely what is the impact on resource allocation of the existing set of government policies is to simulate the effect of those policies. You cannot say anything about these questions using shadow prices for the reasons discussed above.
To answer that particular question you need to build a CGE model, but then I am not sure that that particular question is interesting enough to justify the effort.

2. The discussion of the nominal rate of protection (p. 1-5) confounds the role of absolute prices and nominal prices. The Lerner symmetry theorem reminds us that nominal rates of protection don't matter. It is relative nominal rates of protection that matter for resource allocation. A uniform set of import subsidies and export taxes would give the same negative nominal rate of protection for all sectors. But it would change no relative prices and therefore would cause no resource allocation to change.

3. Similarly, the discussion of the effective rate of protection on page 1-6 is wrong. It is relative effective rates of protection that matter (as Corden [1966] and Tower [1984] discuss). Moreover, as various people have discussed, it is possible for a sector to have the highest relative rate of protection in an economy, and yet for that sector to have its output shrunk by the existing structure of protection relative to what its output would have been under free trade. The thrust of the argument is that free trade might markedly raise the prices of factors that the highly protected sector uses intensively in its output. (See Appendix 6, section 7).

4. (p.1-7) In Tower (1988), I have argued that there are various DRC concepts. I don't know what DRC concept the author has in mind. What does it mean to say that a particular sector is economically profitable? Whether the sector is economically profitable depends on what measures are being used to keep it alive. See Han and Tower (1988). It might be good to use a value added subsidy to keep the sector alive but stupid to use an import quota to keep it alive. Thus, I simply do not know what the author means here by economically profitable. Nor do I know how shadow prices are calculated, so I cannot assess how to evaluate this paragraph.

5. (p.1-5) It is not true that the nominal rate of protection is the difference between market and economic prices if by economic prices the author means second best shadow prices. Using the Little-Mirrlees definition for shadow prices, this is true if the protection is by tariff. However, using the same definition, it is not true if the protection is by fixed quotas, because in that

case shadow prices equal domestic market prices. See Bhagwati and Srinivasan (1981). However, if we confine ourselves to first best shadow prices, then her statement is valid.

6. (p.1-8). I think it is best to talk about nominal rates of protection as being implicit subsidies which cause domestic prices to be higher than world prices. I don't know why economic prices were brought into this at all.

7. (p.1-9) I believe that the DRC used here are designed to represent simply the implicit rate of value added subsidy in a sector, where we treat a preferential credit arrangement as an implicit subsidy and a minimum wage as an implicit tax. This is a useful thing to measure. The author writes that "DRC estimates average 1.46 for manufacturing as a whole. But Table 1.1 shows that this average estimate is not very meaningful since the estimates vary so greatly among the ten groups and 25 subgroups." I would argue that it is not meaningful at all, since it is only relative DRCs that matter. Thus I don't think that the proper interpretation of DRCs is stressed here.

8. Why not eliminate all import licensing and export promotion policies by getting the exchange rate right and eliminate price control, replacing it by free trade combined with exchange rate adjustment?

9. (p. 3-5) It makes no sense to evaluate economic prices of tradeable goods as being world prices and of nontradeable goods as market prices. This corresponds to no sensible way of calculating first best or second best shadow prices that I can think of.

10. (p.3-6) The calculation mentioned in the top three lines does not show "the net impact of government policies on the performance of individual firms." Rather it shows the implicit subsidy on individual firms. My point is ignores the fact that market prices for nontraded inputs and outputs depend on the vector of government policies used, and the calculation as described ignores all this. Thus it is a tax wedge and not a general equilibrium calculation. See Tower (1984).

11. The method discussed on page 3-8 of breaking down the price of nontraded goods into the shadow prices of its tradeable direct and indirect inputs plus the shadow prices of its factors of production is legitimate if we assume all world prices are fixed and that the government is going to hold constant the tariff equivalent of its protection. It does not work if we have fixed import quotas. See Srinivasan and Bhagwati (1978), Bhagwati and Srinivasan (1980), Srinivasan and Bhagwati (1981) and Tower (1988) on this.

12. p.3-7. The reason that Little-Mirrlees shadow price tradeable goods at world prices is not that government officials always have the option of setting policy that will permit more imports or exports at world price levels. It is that holding tariff rates constant, when a unit of a good is drawn by government out of the economy, and the individual is compensated for the loss by a grant of money, he will simply import that good from abroad with a net foreign exchange loss to the economy of that amount of foreign exchange which equals the world price of the good.

13. The idea that the shadow price of nontraded inputs equals their market price which underlies the discussion on page 3-5 is valid only if
a. There are as many factors of production as there are tradeable goods with fixed world prices and not subject to tariffs, so that production is determinate and
b. When the supplies of primary factors of production are altered only the outputs of goods which are not protected by tariffs or quotas alters.

These criteria are so restrictive that it seems outrageous to shadow price these factors at their market prices.

14. I think the discussion of the overvaluation of the exchange rate on page 3-10 needs an important qualification. If the overvaluation is balanced by an ex post balance of payments deficit, the authors are correct. If it is balanced by import restrictions, which generally is the case in LDCs the authors are not correct. It is very important to make this distinction.

15. The definitions of the NRP, ERP and DRC on page 3-13 are very useful and enable us to say how to interpret the authors' efficiency indicators. Using their definitiion and drawing on Gan and Tower (1987), their ERP can be interpreted as follows:

Suppose the government releases a unit of a primary factor into the economy and adjusts value added subsidies and taxes on each sector so that the output of the ith sector and those sectors which feed into it alter, such that net exports of the ith sector alter, but (by varying an additional set of taxes) the net exports of all other sectors are held constant along with consumption of all goods, then 1+ERP, (where ERP is the effective rate of protection of the sector in question) is the value of primary factors used up per unit of foreign exchange earned or saved. This interpretation is valid if the industry is competitive so that at the margin the incremental value of output equals the incremental value of inputs. If the industry is monopolized so that economic profits are nonzero 1+ERP is just the ratio of factor payments to net output of tradeable goods at

world prices, and I have trouble interpreting it as an incremental cost/benefit ratio. For example if an industry is monopolized, if the monopolist gets more protection he may decide to produce less output and jack up the domestic price, since he no longer has to worry so much about competition from imports.

Now, for this figure to be strictly speaking correct, the figure for value added must be for value added directly in the sector and in the nontraded items which feed into it. In other words we must use the Corden measure of the ERP. The authors have used something akin to the Balassa measure of the ERP (I believe), and that has only a very convoluted economic interpretation as discussed in Tower (1984). Of course, if there are no nontraded goods or if the value added in nontraded intermediate inputs is small, there is no difference between the two measures. Also, what the authors did makes no sense unless we can resort to the assumptions used in point 13.

16. The authors' use of the DRC can be interpreted as follows. Their DRC is the value of domestic factors used up per unit of foreign exchange saved or earned. I have trouble interpreting this as an incremental cost/benefit ratio.

17. In work of this sort it is important that the study specify precisely what questions their cost/benefit indicators are designed to answer. To say that they are designed to measure efficiency is not good enough. You have got to say in what sense they are designed to measure efficiency.

18. The DRC being close to 1 does not indicate borderline efficiency except under the extreme case mentioned in point 13.

19. Suppose we discover that some industry has a tiny DRC as calculated by the authors and a negative ERP. It does not follow that we should protect that industry more highly in order to encourage it or that we should force that industry to pay world prices for its inputs and outputs. Suppose for example all of the profits in the industry go to a foreign monopolist. Then encouraging the industry will just make the foreigner richer. Also, as the level of protection of the industry changes, so will both the DRC and ERP change. Thus, DRCs and ERPs, calculated in an initial equilibrium, don't say anything about an incremental change in the level of protection, after we move away from that initial equilibrium.

Conclusion:

I think that the calculations that are done in this paper do in fact come close to the kind of efficiency measures that we want to use as inputs into the policy process. I do not,

however, believe that the authors understand very well the conceptual basis of these calculations. Thus, it is impossible for the policy maker to interpret what these calculations mean. It is important for the authors of studies like this one to lay out what they mean by their incentive and comparative advantage indicators. I think that my two World Bank Working Papers on the subject are useful as are the revisions of these, which I am currently combining into a book. My paper with Gan on Malaysia (Singapore Economic Review) and my paper with Han on Sudan are both examples of the analysis that I believe is appropriate in lieu of ERP and DRC analysis as conventionally done. The reader should pay attention to how I do ERP calculations both for a short run time horizon (in which I hold the capital stock fixed) and for a long run time horizon (in which I assume that over time the capital stock depreciates and must be replaced in order for production to continue. I also think that the cost/benefit ratios constructed there are instructive. I believe that ERPs and DRCs as conventionally calculated should be replaced by these particular ERP and cost/benefit calculations. Note that the ERP calculations do not depend on elasticities assumed in the conceptual economic model of the country, but the cost/benefit ratios do. Thus while the ERP calculations are more robust than the cost/benefit ratios, the cost/benefit ratios come closer to answering the questions that policy makers should be focussing on. Thus, I think all policy reform studies should contain both types of calculations.

APPENDIX 5

COMMENTS ON "ECONOMIC AND FINANCIAL OF SUDAN'S MAJOR CROPS: 1984/85, 1985/87, 1990/91" FINAL REPORT BY DORIS J. JANSEN, NOVEMBER 1986

1. I believe that this paper is a well executed example of the generally accepted methodology for doing DRC analysis of agricultural crops in less developed countries. As such, I believe that it illustrates clearly the flaws of such exercises.

2. For dealing with the particular problem addresed in the paper, I propose the following approach.

3. Any study of a problem like this one needs to start off with a section that describes how the agricultural sector (and the economy as a whole) works. In the current paper, I have no idea whether these agricultural goods are produced by parastatals or whether they are produced by the private sector. I don't know whether individual farmers are permitted to buy unlimited amounts of inputs at market prices, or whether these are rationed. I don't know whether individual farmers can grow whatever mix of crops they want to. I don't know whether inadequate availability of credit is causing the cost of capital to be artificially high to farmers. I don't know whether an imperfect crop insurance market is causing farmers to systematically bias their output in favor of a particular crop, which has a lower expected yield than some other crop. I don't know whether farmers consistently underestimate the productivity of fertilizer. I don't know whether the data consistently underestimate certain types of farm output, because these are sold illegally in the black market to avoid tax. I don't know how important smuggling to avoid the taxation of certain crops like wheat is. I am not told about the regime that Han and I talked about in our Sudan paper which requires wheat farmers to sell some proportion of their wheat at an artificially low price to the government. A good verbal description of how an economy works is essential before it makes any sense at all to calculate things.

4. The effective rate of protection on a sector is the implicit rate of taxation of the sector. I think this is useful information to present. It tells you what the incentives are to produce each type of output. However, it does not tell you what the consequences of that set of incentives are. But as a general rule, output is higher than it ought to be in sectors with high effective rates of protection and conversely.

3. The DRC is a snapshot summary of the relationship between inputs and outputs. I don't think DRCs do much good unless I know why they vary from year to year. Is it fluctuations in rationing, harvests, world prices, domestic prices or wage rates that are causing the DRC to vary. I believe that presentation of

this material needs to be accompanied by descriptions of what the DRCs demonstrate.

4. If I were redoing this study for the Sudan, here are the steps I would follow.

5. First, I would describe my view of how the Sudanese economy works.

6. Second, I would discuss what reforms I believe are needed, what the benefits of these reforms would be, and what questions are to be answered by my formal modeling.

7. Third, I would describe my model of the Sudanese economy verbally and geometrically, i.e. using no mathematics.

8. Fourth, I would describe the results of experiments with the model, to help the reader understand the mechanisms at work and to give the reader a chance to assess the plausibility of the response rates implied by the model.

9. Fifth, I would present cost/benefit ratios associated with policy reforms of various sorts, that are designed to develop a sense of how important various policy reforms are.

10. Sixth, I would draw conclusions about the most needed reforms.

11. Seventh, in an appendix, I would present the mathematical model.

12. Eighth, in an appendix, I would discuss where I got the data, what reservations I have about it, what elasticities I picked and how I decided on them.

13. Now I turn to the exact model that I would use. Here I assume that the truth is that there is no rationing in the agricultural sector. This assumption is designed to be justified either because it is the truth or because we feel that eliminating rationing or at least creating a resale market in the rationed good is a desirable tool of economic policy, noting that if the income distributional consequences of eliminating rationing are adverse, agricultural prices can always be raised by enough to compensate. Also, if there are no nontraded goods, so prices are fixed, creating a resale market in the rationed good will make everyone better off.

14. I would create a social accounting matrix. It would closely follow Han's and my Sudan paper. On the first pass, I would assume two different types of families, urban and rural, who have

different consumption patterns, unless it is true that the government does not tax or subsidize domestic agricultural transactions. If income distribution is not important, I would assume identical and homothetic preferences. There would be an industrial good, a service sector and one agricultural sector. I would look at the effects of changing agricultural input and output prices on aggregate welfare and its distribution. I would linearize the model, because that is easier, than specifying the model in integral form, although the latter specification presents no conceptual or computational difficulties. It is just that it would take me a while to get up to speed on working with nonlinear models. For more on this see section 18.

15. Once, I had made my broad points about agricultural pricing policy, developed my intuition and discussed these issues with USAID people, I would then build a disaggregated model to look at the issues Jansen considers.

16. Here I would have the 10 agricultural goods she considers. I would record inputs of labor, imported intermediate inputs, water and land. I would assume that labor allocates itself to whichever crop pays the highest wage, so that the agricultural wage is uniform. I would assume that land is reallocated only partially in response to changes in relative prices, arguing that different lands have different comparative advantages. This assumption also captures the idea that some farm implements or farmers knowledge is likely to be crop specific and that the development of new marketing and transport channels may not be costless, and that farmers may find it advantageous to diversify. Thus for example, I would assume that if the price of long fibre cotton rose by 1 % relative to all agricultural prices, the land currently in long fibre cotton would increase by 2%, with corresponding reductions in land devoted to other crops. In the short run 2% is too high and in the long run it is probably too high, so it might make sense to vary the figure between 5% and 1%.

17. Having built the model, I would explore the effects on outputs, aggregate efficiency, government revenue, prices, exchange rates and income distribution of changes in agricultural prices and exchange rates. For up to 10 % changes we would calculate absolute (i.e. measured in Sudanese Pound) values. We would also calculate cost-benefit ratios. For example, we would show what the marginal welfare cost of revenue collection via these various devices is. We would also show how much foreign exchange an extra Sudanese pound's worth of labor drawn into a good sector by a higher price for that sector's output or expelled from a bad sector by a lower price for that sector's output would enable us to earn. This is to my mind, the right way to calculate a DRC type concept. This particular calculation

reflects the fact that the model recognizes that every worker-hour of labor that is drawn into one sector is expelled from some other sector, in accordance with the postulated elasticities. Thus, the fact that opportunity cost has already been reckoned with means that we don't need to calculate a shadow exchange rate in order to assess whether marginal expansion of a particular sector is good or bad.

18. Reasons I would be reluctant to calculate optimal pricing in agriculture are:
(a) Putting the model in integral form requires more work.
(b) You lose confidence that you are tracking the economy accurately as you move away from the initial equilibrium.
(c) The existing equilibrium represents a balance of political forces, so it is questionable whether more than a marginal movement is possible.
(d) Any optimum vector of taxes will be contingent on Sudanese industrial policy and trade policy in the industrial sector, and industrial sector policy is so grossly inefficient in welfare and revenue terms that changing it is the first order of the day.
(e) I would want to have a lot more confidence in my parameter values and specifications before I recommended optimum levels deriving out of a model like this.
(f) Misspecifications are more likely to generate crazy results for optimal values than for appropriate directions of change.
(g) I think that political rent seeking is so rampant in countries like Sudan, that the actual policies I would recommend would be uniform tax structures, which guarantee equal treatment for all actors. Thus, I don't think it is desirable to calculate optimal taxes on a disaggregated basis. In fact I think constraints on the variability of tax rates should be written into constitutions as a regular thing, and that constitutional clauses that protect the sanctity of property should prohibit discretionary taxes and subsidies beyond correcting externalities and generating a mild progressivity of the tax structure.

19. If it were desired to assess the impact of moving to a truly optimal set of policies throughout the entire economy, I would use a highly aggregated model like the one discussed in point 14.

APPENDIX 6
DOMESTIC RESOURCE COST AND EFFECTIVE PROTECTION: DEBUNKING SOME POPULAR MISUNDERSTANDINGS

1. Introduction and Summary

Thinking about the DRC is confusing, because there are two different concepts. Bhagwati and Srinivasan in their JPE(1978?) and QJE (1980?) articles define shadow prices rigorously and use these as ingredients in their calculated DRCs. Corden and Krueger in their essays in the Handbook of International Economics talk about DRCs as if there is only one concept of the DRC in existence. They note that if there are no factor market distortions (e.g. minimum wages) then the ERP and the DRC are the same. This runs counter to Bhagwati-Srinivasan. Even though they cite Bhagwati-Srinivasan they ignore the inconsistency of their discussion with the B&S work. In this paper I stick with the Corden-Krueger view of the DRC, which is also the view of the DRC used by Doris Jansen in her work for USAID. I then ask whether her use of the DRC yields the implications she says it does. I answer "No!" And to get the right answer with confidence, I conclude, one must build a computable general equilibrium model, which makes policy recommendations conditional on how factors are combined to produce output and assess the differential effects of using different policy instruments to influence the composition of output and factor use.

2. The Conventional Wisdom

The central idea that runs through Jansen's paper which calculates DRCs for Sudan[4] is that a country has a comparative advantage in sectors which have low DRCs. By this, I presume Jansen means two things. First, under free trade output of these sectors would expand. Second, incremental policy reform (e.g. tariff adjustments) which encourage these sectors to expand is desirable. On page 1 of her section "Guide to Financial and Economic Analysis" she introduces her DRC methodology by noting that it sheds light on "which crops should be encouraged or discouraged by government." She continues (p.9) "If an activity is efficient, it will save or earn foreign exchange; if it is inefficient, its operation cannot have beneficial foreign exchange impacts. In this context, positive economic profitability [a DRC less than unity] is an indication of comparative advantage or the ability to compete in international trade efficiently, i.e. without government assistance."

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4. Doris J. Jansen, "Economic and Financial Analysis of Sudan's Major Crops: 1984/85, 1985/86, 1986/87, 1990/91," November 1986.

With regard to ERPs she writes "A value for the ERP greater than one indicates that the farmer is receiving a net positive incentive on the combination of policies influencing material inputs and sales. Likewise, a value less than one indicates that the farmer is receiving a disincentive."

On the relationship between the ERP and the DRC she writes (p.15): "Because the DRC ratio includes domestic factor costs, it measures not only policy effects on tradable inputs and outputs, but the opportunity costs of using domestic factors in production and can therefore serve as a measure of comparative advantage. ... A DRC less than one indicates the particular activity is economically profitable; in the absence of government policy this activity would produce more than enough value added to remunerate labor and reimburse capital owners. Alternatively, it indicates that Sudan has a comparative advantage in producing a good--or is an efficient producer of the commodity---because the domestic factor costs (G) incurred in its production are less than the direct foreign exchange earnings or savings (E-F)."

3. Insights from the Ricardian Model

Suppose there are many goods, all of which are produced with constant returns to scale under competitive conditions, trade at fixed world prices. Some sectors receive protection from import tariffs and export subsidies. We will postulate small international transport cost wedges to keep the output mix determinate, but we will assume that they are so small that the country would specialize in the production of one good under conditions of free trade. Thus world prices for import goods will be CIF and for export goods they will be FOB. To make life easy, we exclude consideration of intermediate inputs. In this model the value of output and value added are synonymous. We define the nominal rate of protection as the proportional excess of the domestic price above the world price. Since output and value added are synonymous, these nominal rates of protection are the same as the effective rates of protection. The domestic resource cost coefficients would be calculated as these nominal rates of protection plus 1. To calculate her DRCs Jansen uses the market exchange rate. This economy has a comparative advantage in only one good (assuming transport costs are sufficiently small). That good will be the one which Jansen's methodology will indicate to have the lowest DRC. However, if the system is characterized by massive import tariffs and export subsidies on every good, all domestic prices will lie above world prices, and all DRCs will be calculated to be greater than 1, while if the system is characterized by massive import subsidies and export taxes on every good all domestic prices will lie below world prices, and all DRCs will be calculated to be less than 1.

In this model:
-there is no significance to having a DRC above or below unity;
-the country has a comparative advantage in the good with the lowest DRC;
-the standard of living will be raised as steps are successively taken to obliterate production of the good with the highest DRC, then the next highest DRC and so on until the economy is left specializing in only one good.

Conclusion: In this model the DRC does provide some useful policy insight, but only the relative sizes of the DRCs count.

4. The Metzler Paradox

In a two commodity model where the exchange rate automatically adjusts to balance international trade an increase in the import tariff will lower the domestic relative price of the import if the foreign excess demand for the home export good is sufficiently inelastic. The implication is that a higher import tariff causes output to fall in the "protected" sector. This is discussed by Caves and Jones (1985). It nicely illustrates how general equilibrium effects cannot be inferred from just looking at incentive tax and subsidy wedges. Rather you need to look at elasticities as well and actually do a calculation.

If we applied Jansen's methodology in looking at the tariff distorted economy we would find a DRC greater than 1 for the import good and a DRC equal to 1 for the export good. Thus we would be inclined to recommend contraction of production of the import competing good. But this would be a disaster, because as resources were shifted into the export sector, the country's terms of trade would decline by enough to lower domestic welfare.

We would also be inclined to assume that the country has a comparative advantage in the export good in the sense that moving to free trade would cause resources to shift from the import competing sector to the export sector, whereas in reality resources would move in just the opposite direction.

It should be noted that in Jansen's work she is implicitly assuming fixed world prices. In working with DRCs it is important to be explicit about that assumption or else to deal with variable world prices explicitly.

5. Monopoly Power

When monopoly power is present in the domestic economy using

DRCs casually can lead to incorrect conclusions. Suppose world prices are fixed, that the export sector is competitive and that the import competing sector is protected by a tariff and also monopolized. Assuming that the data separates out monopoly rents from costs of capital and land, we would conclude that the import competing sector has a DRC of either more or less then one, depending on whether the Monopolist's average cost was more or less than world price, while the export sector has a DRC equal to one. Suppose the calculated DRC is less than one. This would imply that we want to encourage the import competing sector. If we do so by a higher import tariff or a more stringent import quota, the result may well be a reduction in output as the monopolist decides to raise price to exploit his new-found additional monopoly power. Assuming that average and marginal costs are equal, this would be welfare reducing. On the other hand subsiding the monopoly would be a wise thing to do, as it would encourage him to expand his output. Also, moving to free trade would cause the monopolized sector to expand output, so in this sense the DRC does provide a guide to comparative advantage.

Now assume that marginal cost lies above world price which lies above average cost. In that case, a DRC calculated to be less then unity using average cost figures would erroneously encourage expansion of the sector.

Now assume that marginal cost lies below world price, which lies below domestic price but that the accounting procedure records monopoly rents as payment for management expertise. Then the calculated DRC exceeds unity, but it is desirable to encourage expansion of the industry.

Now assume that average and marginal cost lie below world price, and that the recorded DRC is less than unity. But suppose that the monopolist must continually use up resources in lobbying to preserve his protection. Then the possibility of any additional protection for him or subsidy of his operations may cause him to increase his lobbying expenditures. If this takes the form of resource expenditures, this additional cost needs to be reckoned with. Even if the lobbying takes the form of cash transfers to government officials, if the existence of these transfers causes officials to receive a wage that exceeds the wage in the rest of the economy, they will be inclined to waste educational resources in order to acquire these preferred government jobs.[5] If all of the transfers are competed away in

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[5] If education is subsidized, people may already be buying too much of it, and the artificial expansion of its use will be especially costly.

acquiring education, then the transfers measure the loss to the economy of this deadweight educational loss.

The moral of this analysis of monopoly power is that one must be careful about the use of the data, and one must think carefully about the structure of the industries for which he is calculating DRCs. Casual use of DRCs is inferior to explicit economic modeling, which may either be qualitative (just telling the story) or quantitative (the calculation of cost benefit ratios).

6. Nontraded Goods

Now consider a less developed economy that produces two goods which are traded internationally. The import competing sector is capital-intensive autos. The export sector is beers. Beer is produced with a high ratio of labor to machines, while autos are produced with a low ratio of labor to machines. Both sectors use labor and machines in fixed proportions. Thus the outputs of the two goods depend solely on the stocks of men and machines in the marketplace. World prices are fixed, and the import competing sector is protected with a tariff. All residents have identical tastes, and they each own the same labor endowment and the same number of machines. They each consume a composite commodity which is, for concreteness, a Cobb-Douglas function of beer and autos plus a second commodity leisure. Moreover, they consume these in fixed proportions. Higher real incomes cause labor to demand more leisure, and consequently labor is withdrawn from the market place. When trade is freed up, the economy's real income rises, due to the increased efficiency in the consumption mix. Consequently the consumption of both the composite commodity and leisure rises. Labor is drawn out of the economy. Consequently the labor intensive sector, beer, contracts, while the capital intensive sector, autos, expands.

The calculated DRC for beer is unity, while the DRC for import-competing autos is greater than unity. We might be inclined to argue that the economy has a comparative advantage in labor intensive beers. However, as we lower the import tariff on autos, citizens start to make their composite commodity using more autos and less beer, which implies increased economic efficiency. Consequently, the economy consumes more of the composite commodity and more leisure as well. The consequential reduction of the labor force causes labor-intensive exportable beer to contract while the capital-intensive, import-competing autos, expands. Thus, in this case the DRC has not given us an accurate guide to comparative advantage.

It can also be shown that in a world with nontraded goods,

no domestic distortions, fixed world prices, all citizens who have identical tastes and factor ownerships, and fixed tariffs on traded goods, that it is not necessarily wise to incrementally increase the subsidy on the sector with the lowest DRC, or decrease it on the sector with the highest DRC. The rationale is that an incremental subsidy to a sector with a low DRC will cause the nontraded goods which are used intensively in its production to rise in price. This will cause consumers to buy more of traded goods which are close substitutes for the nontraded good. If these traded goods have high import subsidies or high export taxes attached, so their domestic prices are well below world prices, this is a wasteful use of foreign exchange, and the standard of living will fall.

Again, we see the importance of explicit modeling to assess the impact of free trade or of incremental policy changes.

7. Externalities

Now consider an economy which has one sector, say the fishing industry, in which no property rights exist, so that wild fish are an unpriced resource. If this sector is the import-competing one, and the DRC calculation fails to take account of the externality, then the calculation will show fish to have a comparative disadvantage in the economy. Yet, when trade is freed, the domestic relative price of fish will fall, causing fewer resources there, which will be efficient. If the resources already used there are beyond the maximum-sustainable-yield level, the reduction in protection will actually increase output in the sector and will simultaneously reduce inputs. Thus, once again the DRC fails to predict the sign of the output change in response to free trade. Certainly for this problem explicit model building is a necessity.

8. A Four Sector Model with Two Mobile Factors and Two Sector Specific Factors

Now consider an economy which produces four goods: Apples, Beans, Corn, and Dates. These goods are arranged from the highest nominal protection rate to the lowest. Thus, apples has the highest import tariff or export subsidy and dates has the lowest. Each good is produced with two factors and no intermediate inputs:

Apples=A(K,T);
Beans=B(K*,L);
Corn=C(K,L*);
Dates(L,P),

where K stands for capital, L for labor, T for apple trees and P for palm trees; A, B, C and D stand for the outputs of the four

goods. World prices are fixed. Production is of the constant-returns-to-scale variety. Initially the country is unspecialized. Markets are competitive. This means that the goods are also arranged in decreasing order of DRCs with the DRC of any good that is traded freely equaling 1. The *'s imply that beer is capital intensive relative to corn and corn is labor intensive relative to beer.

Assume for concreteness that corn is traded freely and has a DRC equal to 1. The Stolper-Samuelson theorem tells us that if free trade were to be adopted that the rental rate on capital will fall while the wage rate will rise. Let us assume that the factor proportions in beans and corn are very similar. In that case, the fall in the rental rate and the rise in the wage rate will both be gigantic, and they will be much larger than any domestic commodity price changes generated by the movement to free trade. (For more on this see the mathematical supplement on the Stolper Samuelson theorem in Caves and Jones [1985].)

Since capital is the only variable input into apples (T being fixed in quantity), the output of apples will rise if and only if the proportional fall in the rental rate exceeds the proportional fall in the domestic price of apples, which we postulate to be the case. Similarly, the gigantic rise in the wage rate relative to the increase in the price of dates in moving to free trade will shrink the output of dates. Consequently, we have the good with the highest DRC expanding and the good with the lowest DRC contracting with adoption of free trade. Thus, the DRC is not a great indicator of comparative advantage in the sense of predicting the effects of moving to free trade.

Now let us ask a normative question. Suppose we decide to restrict the output of the sector with the highest DRC, apples by imposing a small value added tax on apples. Pretend that dates is a small sector, so that virtually all of the capital that is expelled from apples ends up in beer or corn. The Rybczenski theorem tells us that since beans are capital intensive, beans will end up attracting both capital and labor from corn. Thus, the effect is to expand the second most highly protected sector and contract the third. If the factor intensities in beans and corn are close together, the contraction of corn and the expansion of beans will be very large relative to the contraction of apples. A very large resource movement occurs from a sector with a low DRC (equal to 1 in this case) to a sector with a higher DRC, (greater than 1). Thus, the prevelent resource movement is to a sector which is less effective in using domestic resources to save or earn foreign exchange means that welfare is reduced by an attempt to contract the sector with the high DRC.

Thus, once again, the DRC is not a reliable tool even for incremental policy reforms.

9. Rescuing the DRC: A Specific Factors Model With one Mobile Factor

The one case where the DRC provides a reliable guide to resource movement and to incremental policy change is when an economy uses a fixed stock of the mobile factor (call it labor) in combination with a fixed stock of a sector specific factor in each sector, to produce a value added composite factor, when in addition the value added composite is combined in fixed proportions with internationally traded intermediate inputs. In this case movement to free trade will cause all sectors with a DRC above a critical limit to contract and all sectors with a DRC below that limit to expand.

Similarly, in this model, when the sector with the highest DRC is taxed more heavily, the output of every other sector will rise and this will be welfare enhancing. Also, if the sector with the lowest DRC is subsidized more heavily, its output will expand and the output of every other sector will contract, which again will be welfare enhancing.

This is the model in which the DRCs as calculated by Jansen and in similar papers will have the most utility.

10. Conclusion

I have argued in Tower (1984) that it is useful to think of the effective rate of protection, modified for factor market distortions as the implicit subsidy to value added in a sector. This calculation is what Jansen calls the DRC. Knowing what implicit taxes and subsidies are is useful, and as a general rule you can say it is welfare enhancing to move tax rates to a roughly common level, and that when this is done the outputs of the initially highly taxed sectors will expand while those of the sectors which initially have low tax rates will contract. However, as this paper has demonstrated that is not always the case. Thus, whether one wants to go beyond DRCs and ERPs is a matter of to what extent one believes the specific factors model discussed in the preceding section describes the world and to what extent one can afford to make mistakes. Finally, in the short run more factors are likely to be specific to particular sectors than in the long run, so that the DRC may be a better short run tool than long run tool.

APPENDIX 7

THE SCOPE OF RENT SEEKING: SURVEY OF THE LITERATURE
BY THOMAS LOO
(DUKE GRADUATE STUDENT CURRENTLY WRITING A THESIS WITH ED TOWER)
NB: This material is not contained on the disk.

APPENDIX 8

SOME CALCULATIONS USING GAMS
BY ED YURCISIN (A JUNIOR AT DUKE CURRENTLY ENROLLED IN ED TOWER'S COMPUTER MODELING FOR ECONOMIC POLICY CLASS)

NB: His material is available in a separate folder.

APPENDIX 7

The Scope of Rent-Seeking: Survey of the Literature

By Thomas Loo

Rent-seeking behaviors are privately profitable activities that yield pecuniary returns for its participants but are directly unproductive for or directly detrimental to the economy. Real resources are used up in pursuit of monopoly profits that may exceed the rents and the deadweight losses of monopoly. Krueger (1974) introduced the term "rent-seeking" into the literature to indicate the wasting of real resources by competition for artificially created rents. Such opportunities are possible when government intervention impedes market adjustment processes by inducing scarcity. Entrepreneurs anticipating such rents spend resources to obtain the monopoly rights when they are created or seek ways to replace the initial recipients. Another form of rent-seeking occurs when prices are not free to adjust to competitive levels. Actors who have been awarded government created rights to enter the market on the demand side reap the rents when entry is blocked. Other demanders will waste resources in seeking these monopoly rights.

The early literature by Tullock (1967), Krueger (1974) and Posner (1975), reach the common conclusion that competitive rent-seeking by risk neutral agents would dissipate the rents sought. Economic surplus, like monopoly profits, attract rent seekers who will spend real resources up to the value of the rents sought where the last dollar invested equals the improved probability of getting the monopoly. Since only some of the many anticipated

rent seekers are successful, the total resources committed may well exceed the possible profits. This is analogous to a lottery in which most tickets buyers lose a small amount and only a few win a large amount, and the sum of tickets exceeds the payoff (although it is common to assume these are equal). There is a redistribution of resources from the unsuccessful to the successful bidders along with a waste of resources directly and because the same resources could have been employed in productive activities. Many other interventions in the market besides monopoly, such as a minimum price or a tax put on X persons to benefit Y persons can also have redistributive effects, and involve resources wasted in getting such rents.

In developing countries, the available evidence is that rent-seeking related losses are very important. Krueger (1974) estimates that these may be as high as 7.3 percent in India and 15 percent of national income in India and Turkey respectively in the 1960's. Mohammad and Whalley (1983) re-estimated India and allowed for additional quantity restrictions to obtain losses that go up to 30-45 percent of GNP. Grais, DeMelo and Urata (1986) estimates for Turkey that inclusion of rent seeking from quantity restrictions on competitive imports of intermediates results in real GNP and wage drops. Robinson and Tyson (1985) estimates that rents from foreign exchange rationing schemes in Yugoslavia ranged from 3.4 to 13.7 percent of value added in 1980.

From the empirical literature, welfare losses from rent-seeking are larger than those from traditional price distortions (such as from taxes) based on Harberger-type triangle measures. This is because with price distortions, resources are still in use, albeit misallocated to less efficient uses. Rent-seeking makes resources idle, or used up in activities with no welfare value. More important, the results are directly sensitive to the particular microeconomic scenario implicitly assumed for the specification of the rent-seeking activity.

The conventional assumption is that the efficiency losses from rent-seeking is approximated by the value of rents sought. Krueger (1974) assumed that in equilibrium, the average return, including rents, of a factor engaged in rent-seeking must be equal to its earnings (wage) in alternative employment (which happens to be the competitive agricultural wage rate). This equilibrium condition implies that the opportunity cost of the rent-seeking activity is equal to the value of the rents sought.

Most of the empirical studies have followed this assumption, but Blomqvist and Mohammad (1986) demonstrated that the value of efficiency losses from rent-seeking depend on the specification of precise "rules of the rent-seeking game". By varying the way rent yielding licenses are allocated, the efficiency of other distortions, such as taxes in the economy is altered.

Two types of rationing mechanisms have been used. In the first and most common, once goods have been allocated, they are

resold at a higher market price, and competitive agents are assumed to be able to influence the amounts of goods they are licensed for. Dervis, DeMelo and Robinson (1982) and Grais, DeMelo and Urata (1986) however postulate a direct rationing mechanism whereby goods go to end-users and cannot be resold. The rents are thus implicit, and are the difference between what users willingly pay and the controlled price actually paid. Here, rent-seeking activity is confined to the end-users. Lobbying can influence the amounts allocated so that again, resources devoted to rent-seeking is equal to the value of rents. It is not clear whether a resale prohibition increases or decreases welfare overall, although it influences the form of rent-seeking.

In most studies, a constant returns to scale function relating the amount of rent-seeking activity to the resources withdrawn from productive activity is assumed, and each agent gets a share of the licenses equal to his share of rent-seeking activity. This formulation implicitly assumes that agents who seek rents get all the rent generating assets by using resources pulled from productive use to be devoted to rent-seeking. This type of rent-seeking activity is akin to simple queuing where the amount of licenses for imports allocated is proportional to the amount of queuing. Other types of allocation mechanisms can be postulated: auctioning or allocating of licenses by corrupt officials, allocation to firms with specific production or with large capacity. It is obvious that the welfare losses estimated is

highly sensitive to the particular specification used. Without better empirical support it is difficult to assume that any particular specification is reasonable.

A related literature is that of smuggling. Large portions of the foreign trade of many developing countries can be accounted for by illegal transactions, and this gives an indication of the magnitude of rent-seeking losses. Indonesia in the 1950's and 1960's suffered pervasive smuggling of agricultural exports. Pitt (1981) estimates that the price disparity due to smuggling increased the domestic price of rubber, a major export, by an average 39 percent and sometimes double, of the legal price. He states, "It is not surprising that the price effects of smuggling seem to have completely counter-balanced the price distorting effects of Indonesian trade policy during the 1960's."

A great deal of government activity reflects rent-seeking behavior as does tariff or license lobbying and tariff evasion, but these need not be policy intervention related, as Tullock (1973) shows in the case of theft. Bhagwati (1982) has expanded the rent-seeking concept to more broadly, "directly unproductive profit seeking (DUP) activities" where the welfare consequences of policy measures can be dramatically different when there is the paradoxical possibility of welfare improvements by rent-seeking (broadly defined). In the simplest case, such activity by diverting real resources from productive to unproductive

activities in the context of initially distortion free situation, the loss in resources is a social loss. In a distorted situation however, it is second best and may be welfare improving if the activity destroys a distortion and results in a first best optimal outcome. The paradox of welfare improvement from a directly unproductive activity is analytically the same as the orthodox paradox of immiserizing growth and the dual of the case of negative shadow prices for factors (Bhagwati and Srinivasan, 1982).

For example, in a open economy where the extra real costs of illegal trade are reflected in traded goods, smuggling, defined as evasion of trade taxes or restrictions, cuts the effective tariff even as it uses up real resources. That is, smuggling is treated as having a less favorable transformation curve in a standard open trade model. The losses from smuggling can be less than the production and consumption gains, and is thus beneficial rather than immiserizing. Other examples are tariff destroying lobbying, legal and illegal (bribery), and resource and premium seeking, which includes rent-seeking as a subclass. These possibilities complicate the assessment of welfare costs of policy measures under a variety of institutional distortions.

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