THE NEMS CONFERENCE

# MACROECONOMICS: NATIONAL MODULE PANEL

**February 1, 1993 - 10:00 am**

**PANELISTS:**

Gerald E. Peabody, Moderator
Ronald F. Earley, Presenter
James A. Edmonds, Reviewer
James M. Griffin, Reviewer
G.S. Maddala, Reviewer

**AUDIENCE PARTICIPANTS:**

Joyce Yanchar
Gordon Richards
Tom Elias
Dan Santini
Bob Trost

EIA

PROCEEDINGS

MR. PEABODY: Welcome to our session on Macroeconomics: National Module. If you're not interested in macroeconomics and interested in something else, you're in the wrong room.

I'm Jerry Peabody. I'm the Chief of the International, Economic, and Integrated Forecasting Branch, which means they lumped together in this branch everything they didn't know what else to do with. That is why the name goes on forever. One of the things that we do is the macroeconomic modeling which is an important element in the NEMS system.

The person who heads that work in EIA is Ron Earley, who will be presenting a discussion of the national module.

Then, commenting on the report by Mr. Earley and the papers that have been written about the module will be Dr. James A. Edmonds from Pacific Northwest Laboratories, Professor James Griffin from Texas A&M, who is probably happy this morning, and Professor G.S. Maddala from the Department of Economics at Ohio State University, who is currently at Cal Tech.

We'll start with the presentation by Ron Earley. He's been doing macroeconomic analysis for the Energy Information Administration and its predecessor agencies for a good number of years now. We're getting where we don't like to count them anymore. We have made a little bit of a jump on the rest of the NEMS system in that we have a reduced form model already in place for the macro model, and we also are linking the full DRI macro model to the NEMS system. Ron will give us an overview of this system.

We're going to take questions. We have sufficient time both for the talks and questions. I think it would be best to hold your questions until the end of each talk and we'll try and take a few questions after each talk and then have time for a general discussion at the end.

MR. EARLEY: I want to very much thank everybody for attending today. I want very much to thank the reviewers today. You just don't know how glad I am to be here for many reasons today, not the least of which is that we are going to get some interesting debate, I hope, during this conversation. I encourage you -- my number at the office is 202-586-1398 -- if you have any questions about this, I want you to give me a call. Let me introduce some key people who are working with me: Kay Smith, Brian Unruh, Jason Altman, and Carl Moody, who is a professor down at William and Mary.

I must say, with this distinguished group that I've got around me, I feel as though I'm going to defense on the thesis with a lot of observers sitting in the room. The Macroeconomic Activity Module, let me just state, has three submodules to it. I am going to talk today about the National Submodule. The session beginning at 1:00 this afternoon will talk about the Interindustry and the Regional.

I'd like to focus on what the requirements are for the National Submodule in the context of what's going on in NEMS. There are essentially three system requirements. The first is to

# Macroeconomic: National Module
## in the
# National Energy Modeling System

212

**Ronald F. Earley**
**Energy Information Administration**

EIA

**February 1, 1993**

**OIAF 1/93**

# System Requirements

- o Provide a Set of Essential Macroeconomic Drivers
- o Provide a Macroeconomic Feedback Mechanism Within the Integrated Model Set
- o Provide a Mechanism to Evaluate Detailed Macroeconomic Impacts

OIAF 2/93

provide an essential set of macroeconomic drivers. What this means is basically all the demand models and the supply models out there, every one of them looks to me and the modeling system that I've got to provide them with information. The National Submodule provides them with a set of drivers that allows them to do their business of doing their forecast. So, we have an integration issue that isn't just feeding one module, but we have to deal with each and every one of the 12 or 13 different major groupings of models within NEMS. So, there's a lot of phone calling that goes back and forth between analysts. There's a lot of sneaker net carrying floppy disks back and forth. But we have to provide this essential set of macroeconomic drivers.

The second thing that we need to do is provide a macroeconomic feedback mechanism within the integrated modeling set. What this means is when something changes in the energy system, the macroeconomic component has to be altered as well so that when energy prices go up, the economy adjusts in an appropriate fashion. Then the third thing that the system is supposed to provide is a mechanism for doing detailed analysis where required. This detailed analysis may mean the off-line use of various modeling systems to do analyses of topics that may be beyond the scope of what we're going to build into the direct NEMS model.

Like I stated before, the Macroeconomic Activity Module has three submodules, National, Interindustry, Regional. The response surface version of these three models will represent the core of what we're going to represent within the NEMS system. So, we will have response surface versions of the national, interindustry and the regional models, and that will be the core of what will be inserted into the NEMS system. However, for specific analyses, we are going to have a direct link with the DRI model. I'll go into this in more detail, but essentially there we have acquired the model, we're going to put it on the mainframe and we're going to have direct links with NEMS. I will try and be precise in my wording here. The definition of NEMS will include the response surface versions of the model. NEMS, in and of itself. The DRI model will be outside the boundary of NEMS, but we will have direct linkages with the DRI model so that we can run that in an integrated sense for a specific special analyses.

Also, to reiterate, what we're talking about today is going out to the year 2015. As Andy Kydes mentioned this morning, we've got an effort where we're beginning to look at long-run growth issues. A key component to that will be how we deal with the national economy, how we deal with energy in the context of that economy and how we deal with technology issues over the long-run. That effort will be going on for some time. As an aside, what I encourage anybody to do if you've got any opinions about the long-run modeling in addition to this, although we won't get into long-run today, if you have any questions, comments, concerns, make sure -- get to me, get to Andy, get to anybody within Mary Hutzler's office and we'd love to talk to you about longrun modeling issues.

This is the lay of the land. This little flow chart tries to show what we're going to accomplish in the building of the macroeconomic activity module. Of course, this is the macroeconomic -- I get the idea that this is the Australian map of the world. I've necessarily reduced all the NEMS energy stuff into that little block in the corner. I won't say that's appropriately where it belongs but this is the macroeconomic view of the world.

Essentially what we're going to do if you follow the top line, we're going to receive a bunch of inputs from the various system. I'll go over those in a minute. First decision will be

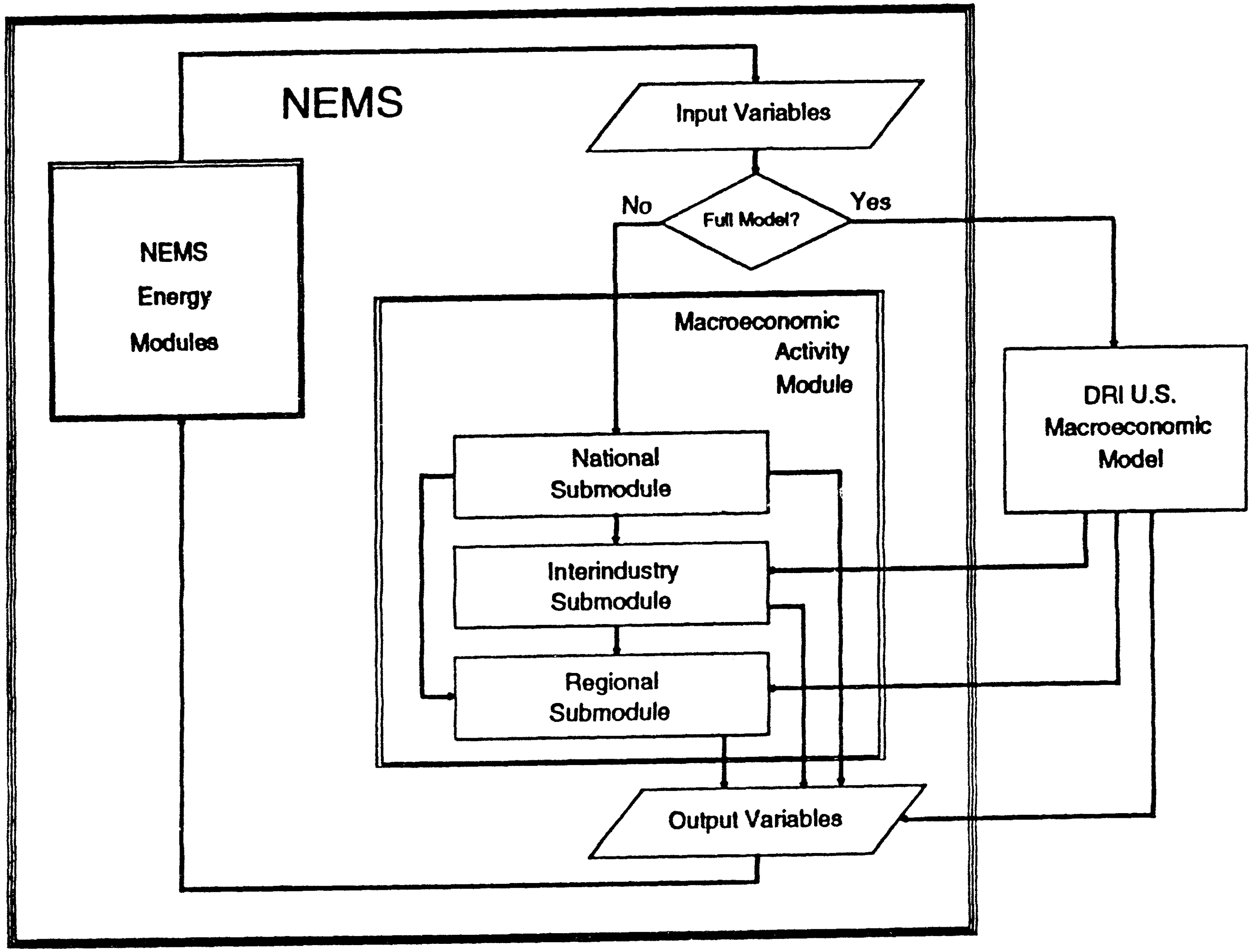
# Statement of Purpose

- The Macroeconomic Activity Module is a Linked set of Submodules:
  - National
  - Interindustry
  - Regional



- Response Surface Models Will Constitute the Core Subcomponents of NEMS
- For Special Analyses, a Design Goal is to Link the DRI Macro Model Directly to NEMS
- Forecast Horizon - To 2015

# Overview of NEMS Macroeconomic Module




OIAF 2/93

do we run the large DRI model or not? If the answer to that is no, then the inner box there will talk about the Macroeconomic Activity Module and we will run in a series of sequential steps, the National, Interindustry and then Regional. Then that information will be put back out of our system, back into the entire NEMS and made available to all the supply and demand modules. Then the process iterates around. The convergence process may be year by year where convergence is reached with any year and then you move on to year two, or in some circumstances you may run each model all the way through the entire time frame and that entire time frame of information is passed onto the system.

These are types of issues that may come up in the integration talk. I hope I haven't forced the issue on that particular topic, Susan.

As I mentioned, the national response surface model will be the core of what we're going to be talking about in this session today. It's based on the DRI macroeconomic model. Specifically it's the quarterly model which runs out -- has a forecast period through the 2015 time that we're looking at. The fundamental thing that we're trying to accomplish with the national model is as follows:

We generate a baseline forecast using the full DRI model off-line, essentially with a starting point in terms of growth rates for the economy as a whole. We may adjust that based on an initial world oil price path that will be provided elsewhere within EIA, within our office, and then we will generate a baseline forecast and that baseline forecast will be inserted into the national submodule as a starting path. The essence of the response surface model is -- and I just want to be very clear about this -- we have a baseline forecast the essence of the response surface model is to calculate changes from that baseline, so that if energy prices go up and there is a profile of impacts on the economy, the economy, loosely interpreted may go down in that situation, but there may be some oscillation. What the response surface national model will do is to calculate those changes from a baseline and generate a new set of levels. Those pieces of information will then be passed back to the rest of the energy modules for them to act on, and then, hopefully, things converge.

So, it's essentially a system which is set up to respond to changes in the energy system forcing changes in the macroeconomic environment. Some people may have different interpretations of exactly what is response surface -- the reason why I use response surface as opposed to reduced form is I think that's a better characterization of what we are doing with the DRI model. We are basically looking at the response of the full DRI model to changes in energy events and energy prices and quantities and we are trying to replicate those changes of the national model.

Now, we're going to add a new capability, a new wrinkle. Let's say as an analyst I give you 2-percent growth over the next two decades and I may actually give you an option. I may give you three different growth rates, three initial growth paths. But you, given your interest or your views, may differ with that. You may think that the economy is going to grow faster or slower.

So, what we're going to build in here is the capability to adjust the macro model up or down in order to account for supply side and that's always a dangerous term to use in

# The National Response Surface Submodule

- o The Core Macroeconomic Component of NEMS
- o Based on the DRI Macroeconomic Model
- o Responds to Energy Price Changes
- o Add Capability to Adjust the Growth Path of the Economy Based on Supply-Side Factors

  Labor - Capital - Productivity
- o Assimilate Incremental Investment Requirements
- o Used for AEO and Most Energy Analyses

OIAF 2/93

Washington, supply side. So, we want the user to be able to adjust up or down the long-run growth rates reflecting different views on the long-run potential output of the economy. So, we will put in levers that will allow you to adjust labor, capital stock or an aggregate productivity change.

The other thing that we are hoping to accomplish in this which is different than our response surface modeling in the past is to assimilate information about investment requirements. This will be a tricky question because basically it requires extracting very much information from the energy supply modules first, but potentially even from the demand models because you can expect that the requirements that may be out there coming from the energy supply side or the demand side of the system, there are capital requirements associated with those. We would like to pick up those capital requirements and use those and implement those to look at how it does have an effect on the economy. So, we're going to go down this path of trying to pick up investment requirements so that we can evaluate the response to the economy to these changing investment requirements.

Some of the points on the next slide I've already made, so I'll go through this one first. Let me reiterate. Our typical action will be to provide three base cases and then the user will have the option of making incremental changes. Now, I will stress the word "incremental" here because I don't want you to think that you can take the response surface model and say you want to change the growth rate of the economy by a full percentage point over the next 20 years. If I leave you with one thought about response surface modeling, it is this. You have to design the response surface model in a very careful way and describe exactly what boundaries that response surface model can be used in. Now, that's a caveat that should be applied to all models. But particularly on the response surface, I think you want to be careful about saying that the response surface model can do a large change, let's say a full percentage point change in growth, when in fact we're going to be designing it in such a way that you can incrementally push up the growth rate by a tenth of a percentage point or two-tenths of a percentage point.

So, I think that's one caveat in general about models and in specific about the response surface. You've got to be very explicit about what conditions can you use the response surface modeling in.

Now, the response surface -- I'll try and keep track of time here. I want to leave plenty of time for the reviewers' comments -- starts with a baseline, which basically models the response in various macroeconomic indicators. Essentially what we're going to pick up on are various fuel prices that exist in the energy runs on coal, natural gas, electricity and refined products, as well as we'll pick up on various energy quantities to determine macroeconomic final demand, let's say for personal consumption of gasoline.

That basically describes in a very short manner the response surface model. It is useful, I think, to talk about how the linked DRI system is thought to be used. There's going to be a number of really tricky analyses that may exist out there. I've listed as point Number 1, energy taxes. It's foremost on everybody's mind these days. And any various regulatory analyses, such as CAFE. What we have -- and this basically is an outgrowth of my immediately preceding comment about you've got to decide how far you want to go down the path in terms of you use the response surface and when you turn it over to the larger structural model.

# Alternative Growth Path

- Three different macroeconomic growth paths available

- Incremental adjustment of economic growth also possible changing

  Labor Force
  Productivity
  Incremental Investment

- Incremental adjustments of growth intended for small changes in growth rates.

# Response to Energy Price Changes

- o Starts with baseline economic growth path.

- o Models response of macroeconomic indicators used by the energy models to changes in energy prices.

- o Uses a price index of fuel and power whose components include:

  Coal
  Natural Gas
  Electricity
  Refined products

OIAF 2/93

So, we'll be in this process of trying to define what the scope of one is and where do we pass the baton to the other model. But we do recognize, based on past experience and on expectations, that we're going to have a number of cases where we need the larger structural models such as the DRI model we have chosen, and we have talked about this extensively in the CDR, we are going the route of the DRI model. I will say, to pick up on one of Andy's points and Mary's points earlier today, the term "modularity" is a design goal. Difficult to achieve, but one of the objectives here is having the potential for, for example, taking any module and removing it and being able to put another module in its place.

Now, you have some very severe constraints here in terms of you've got to make sure you match up on the inputs and outputs and that, so it's not an easy task. But the idea here is modularity. So, we have decided to use, for reasons that I think are entirely appropriate for the mid-term analysis that we're doing here. I would say the DRI model is that class of models that does a good job of looking at the adjustment cost mechanism in the economy. There are other views of looking at longrun growth issues that may be more of the Wilcox and Jorgensen sort of approach. But what we have settled on is a model that will do a good job of looking at the adjustment process over the next 5, 10, 15, 20-year period of time.

So, we will make the linked version of the model available to other people within the Department. As far as the availability of that system external to the department, that would have to be a negotiated agreement. Essentially, the issue here is we have a proprietary model and you've got to deal with those issues of proprietary nature of the model. If anybody has any separate questions on that, we can talk about that later.

Linkage to the DRI model, next slide. We're going to put it up on the EIA mainframe. Now, I will say that this has never been done before. We're finding that out. The reason why I'm pausing on that is all the issues related to putting it up on our mainframe are scampering through my mind right now. But the fundamental point here, we're picking up the source code. We're putting it on our mainframe and we are putting it up in a fashion such that we can link it straight to NEMS. This means that we're going to have a series of pre and post processors which will extract information, translate it into a format that can be run by the DRI model on the mainframe, crank the model, spit out results at the end and let it go back straight in. Where that information will come back in -- at the last thing I'll leave you with, we'll put the flow chart back up again -- that information will come back in and feed into the interindustry and to the regional submodules. Both of the regional and the interindustry submodules will remain response surface versions. We have structural versions of those models, but they will not be -- at this stage we're not planning, nor will we implement those as direct links in the same fashion we're doing the DRI quarterly model.

Then, revisions to the model, one thing that I have in mind that I would very much like to do is essentially the DRI model has a small energy block in it that when we make these linkages we override those linkages. We basically control on those energy price and quantities.

One of the things that I would like to do is to take the DRI model, and gut the energy portion of it. Basically -- I hope I'm characterizing this right -- the energy portion of the macro model is nothing but kind of a reduced form version of the larger DRI energy model. So, we're going to take out the energy equations, we will put in a NEMS-like set of response for energy

# Use of the Linked NEMS-DRI Quarterly Model

- Analysis of optional energy policies with complexities beyond the scope of the response surface model.

  Examples include:
  - Energy taxes combined with rebates
  - Combination of energy taxes
  - Regulatory analysis

- Linked NEMS-DRI Quarterly Model will be available to DOE personnel and other agencies or organizations having negotiated a prior agreement with DRI.

# The Interindustry Response Surface Submodule

- The Core Industrial Output Component of NEMS
- Based on the DRI Input-Output (PCIO) Model
- Used with Either Response Surface National Submodule or DRI U.S. Model
- Calculates Changes in Interindustry Activity Necessary to Satisfy Changes in Final Demand

# Linkage to the DRI Macroeconomic Model

## INITIAL LINKAGE

- Put Up On EIA Mainframe, with Pre- and Post-Processors
- Develop Energy Price and Quantity Links
- Assimilate Incremental Investment Requirements

## REVISIONS TO THE MODEL

- Replace Energy Block of the DRI Macroeconomic Model with NEMS-Like Energy Block supply and demand, and it's possible we could actually have a full model on board that would behave in a NEMS-like fashion with respect to energy internally. This would then give us a version of the DRI model that has energy pass-through behavior that is NEMS-like as opposed to the DRI energy model-like.

So, that's on the drawing board. That will occur only after we've tackled all the tough questions about putting the full model up.

Let me just tell you very quickly that the interindustry will be also response surface. We'll be talking about that this afternoon. It's based on the DRI PCIO model which is basically DRI's large I/O model. But it was totally restructured to our specification of the sectoring plan which basically follows the national energy accounts sectoring plan. The response surface version of the National Submodule will be used as linked to either the National Submodule or to the full DRI model. So, either one of those ways will feed into the interindustry model.

Then the last point is -- well, the last point on the interindustry is that it basically responds to changes in the macroeconomy, changes in final demands essentially.

Very briefly, the regional response surface model will follow the same sort of approach. It will be used with either the National Submodule or the DRI model and it will calculate changes in regional activity consistent with changes in national and interindustry structure. Just for those people who won't be in the afternoon session, basically we're talking about a nine Census division structure of the economy, so it will not be state by state. It's nine Census divisions to satisfy other demands within the entire NEMS system.

I have a couple of other slides which later on may be useful to put up to demonstrate some of the performance characteristics. But at this point let me turn it over. Thank you very much and I encourage you, please, be candid in any of your comments today and anything you want to say, get to us, we'll talk.

MR. PEABODY: When you have a question, there is a portable mike that we can move around the room. We are making a set of recordings of this session, so we would like to get your questions in the minutes as well as the talks here. When you ask a question, wait until the mike gets to you.

We'll take the reviewers in alphabetical order. I won't come up here each time. They can just come up one after another. We'll start with Dr. James Edmonds.

DR. EDMONDS: Let me just begin by thanking EIA and in particular Ron Earley for inviting me to be here this morning and to comment on Macroeconomic Activity Module.

Ron and I have had a conversation about the macroeconomic component of the NEMS model that dates back to a problem we jointly addressed a couple of years ago in putting together a report to Congress called "Limiting Greenhouse Gas Emissions in the United States." We were looking at the energy economy feedback and we began talking -- at that time we were using the DRI model to look at some of the tax recycling issues and we began discussing the issue of how best to tackle the problem of analyzing the costs and benefits of alternative policy

# The Regional Response Surface Submodule

- o The Core Regional Output Component of NEMS

- o Based on the DRI Regional Model

- o Used with Either Response Surface National Submodule or DRI U.S. Model

- o Calculates Changes in Regional Activity Consistent with the Changes in National and Industrial Activity

NEMS
Workshop

# MACROECONOMIC ACTIVITY MODULE REVIEW

---

Comments by

Jae Edmonds

1-February-93

Pacific Northwest Laboratory

Washington, DC

instruments for reducing that greenhouse gas emissions.

So, in thinking about my comments on the Macroeconomic Activity Module, I began by going back and taking a look at the overall NEMS structure. The NEMS structure is a fairly sophisticated structure of the energy system with ties to the rest of the economy. If you look over here -- this is my characterization of it, but if you look over here there are four modules which really focus on the production of energy. There are three modules which focus on transformation of energy, and there are four modules over here which focus on the end use of energy. Then there are two modules which occur at the top of this diagram, macroeconomic activity and international energy, which tie the energy system to the rest of the world. The Macroeconomic Activity Module ties the energy system to the rest of the United States. The other economic activities in the United States and the international module ties the model to the rest of the world.

All these pieces are knitted together in a systems integration box. So, the Macroeconomic Module has to be placed in this context of a much larger energy system. Then you go back and you say, "What are the characteristics? What are they out to do? Are they set out to be modular?" They wanted each one of those boxes to basically be able to stand on its own feet. They wanted a transparent system. They wanted to have each of those boxes be understandable in its own right. I think if I were to rephrase it that any one individual can tell you -- can come to grips with everything that's going on in each one of those boxes.

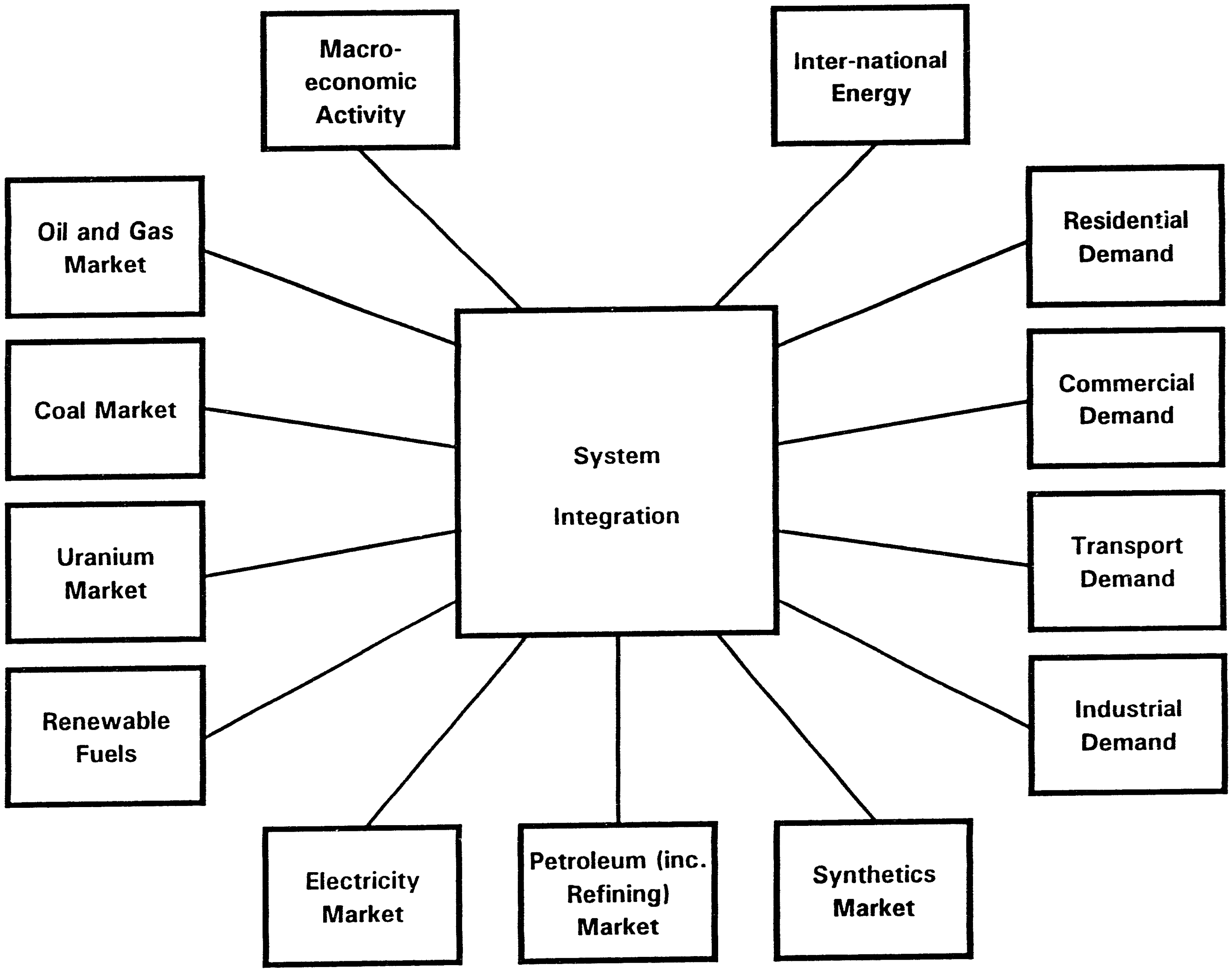
This is really interesting. They have extended the time horizon. There are two models, there's a mid-term and a long-term. The long-term goes out 40 or 50 years. You really need to do this if you're going to deal with the issues that are on the table when you get to energy in the environment, and that's down here, environmental issues. It has regional coverage and that, of course, comes back to some points I'll discuss later. The issues that EIA will be asked about have more regional aspects. Finally, it addresses the problem of uncertainty. All of these, I think, are really steps forward.

While we're talking about environmental emissions, let me just make one comment. If you really are going to tackle the greenhouse issue at some point, it is very important to add one more gas to the list of gases, and that is methane. It's not a particularly hard gas to add. If you can do carbon monoxide, you can do methane and it's very important if you're going to have a system which is capable of describing them, the important emitters of greenhouse gases.

So, the rest of my comments are going to focus back on this box up here at the top, the macroeconomic activity and how it relates to the rest of the model.

Let me begin where Ron left off -- why do you need a Macroeconomic Module in the first place? He identified three things, and I've rephrased these a bit, but they are, first, to determine the scale of the energy system, the scale of human activities that are going on underneath that drive the whole energy modeling system. Secondly, you want to link that system scale to the energy system feedback, and thirdly you want to assess economic impacts of various policy instruments. I think one and three are probably the two most important, and the reason I say that is if you look at the typical kinds of impacts that you encounter in doing

# THE NEMS MODELING SYSTEM



MACROECONOMIC ACTIVITY
MODULE REVIEW

# CHARACTERISTICS OF NEMS

Modular Design

Transparent System

Extended Time Horizon
(40-50 years)

Regional Coverage

Environmental Emissions

Addressing Uncertainties

MACROECONOMIC ACTIVITY
MODULE REVIEW

# FUNCTIONS OF THE MACROECONOMIC ACTIVITY MODULE

Determine System Scale

(Link System Scale to Energy System Feedback)

Assess Economic Impacts of Policy Options energy economy analysis, the feedback to the system would be -- I think feedback would be one or two percent change in the system drivers, a fairly major policy intervention.

Now, typically that's going to be affecting a system driver which over the course of analysis has changed on the order of 100 to 200 percent. So, that's well within the noise of the system. On the other hand, if you're looking at one to two percent change in GNP and you're interested in the issue of cost, that's a big number and that's something that you have to pay very close attention to. These, of course, are linked, but it is the assessment of economic impacts where those kinds of percentage changes are extremely important.

Taking a look at the impacts since you're not going to set aside the problem of determining the overall system for the moment. If you look at the energy impacts, what do you want to be able to do? Well, you'd like to be able to perform some kind of cost benefit analysis. Typically EIA is going to be asked about employment, "Are people going to be unemployed in my district? What's inflation going to look like? What are the regional impacts? Are the industries that are hard hit by a particular policy or benefitted by a particular policy intervention, are they in my district?" So, this regional notion, of course, is something that they're going to be continually asked about.

Finally, international trade and competitiveness are going to be issues that are going to have to be addressed.

There are two questions that I thought I could comment on. One, does the present configuration of NEMS provide an adequate basis for an evaluation of the impacts of energy-related events on the U.S. economic system? And the second issue is one that has come up, what is the value of a reduced form representation of the Macroeconomic Module in evaluating the ability of NEMS to do cost/benefit?

As Ron said, the Macroeconomic Module is the DRI model. The DRI model has a great deal of detail which describes the realized GNP. On the other hand, the DRI model has very little detail describing the relationship between energy and the economy and potential GNP. If you look at the potential GNP equation, what Ron referred to as, in a sense, the supply side of the model, it's one equation. It's got labor, it's got capital, it's got energy and a scale factor. The impact on potential GNP of the energy system is only through this term which is aggregate energy consumption. That, of course, leads to some problems if you're trying to do analysis that has any sophistication to it because ultimately it's the energy services that matter, not the energy. So, if you have a policy intervention which improves the efficiency in which energy services are delivered, therefore reducing energy consumption, you would have as a consequence of that changeover in technology a model saying, "Well, the potential GNP is lower than it was before," but in fact actually you're delivering all of the same services to the economy and, in fact, have freed up some resources that could be used elsewhere in the economy.

So, the simplicity of the model, I think, misses some of the sophistication of the energy economy interactions.

Then the present potential GNP description can't describe the energy economy through sectorial interactions. For example, energy and agriculture interactions through a biomass or

NEMS
Workshop

## MACROECONOMIC ACTIVITY MODULE REVIEW

# ENERGY POLICY IMPACTS ISSUES

Cost-Benefit Analysis

Employment

Inflation

Regional Impact

Trade

## MACROECONOMIC ACTIVITY
## MODULE REVIEW

---

# NEMS AND THE MACROECONOMIC MODULE

**Does the present configuration of NEMS provide an adequate basis for an evaluation of the impacts of energy related events on the US economic system?**

**What is the value of a reduced form representation of the macroeconomic module?**

MACROECONOMIC ACTIVITY
MODULE REVIEW

# NEMS AND THE DRI MODEL

The DRI model has a great deal of detail which describes realized GNP.

The DRI model has very little detail describing the relationship between energy, the economy, and potential GNP.

# MACROECONOMIC ACTIVITY MODULE REVIEW

## DRI POTENTIAL GNP EQUATION

$$Y = Ao\ L^{(.62)}\ K^{(.33)}\ E^{(.05)}$$

NEMS detailed energy models affect potential GNP through aggregate energy consumption.

a carbon tax with reforestation offsets. These are potentially very important interactions that are going to go on in the economy that you really want to pick up on if you're going to get serious about doing analysis of the greenhouse gas emissions reductions.

I put up as a counterpoint to it the work that we're doing on what we refer to as the second generation model. In this model we have still a relatively simple system, but one in which you have energy in the middle with simple descriptions of oil and gas production, etc., but also relationships to agriculture, other products through factors of production, land surface and subsurface, resources, labor and capital through household and government sector. The model is capable of addressing those kinds of issues, of dealing with the energy service issue, of dealing with the linkages to other parts of the economy.

Let me just say why I think this is important, because if you look at some of these long-term issues, then that potential GNP becomes the part of the analysis that really matters. It's the asymptote for these models. If it's 5 or 10 years down the road, then you've really developed a fairly strong case that the demand side of the system is extremely important. The further out in time you go, the more powerful that asymptote becomes and the more that governs your end result. So, if you're going to go out 20, 30, 40 or 50 years, this supply side, this potential GNP side of the economy is probably the single most important component of your analysis. It's going to drive your results. I think you want to have something there which is a bit more sophisticated than a simple single equation, which may very well be quite satisfactory in a short period of time, but in the long haul I think it's going to be really unsatisfactory.

This is my opinion and not being charged with actually executing this, it's very easy to hold this opinion. But I think that ultimately there is a need for a new energy-oriented macroeconomic model which has an enhanced description of the potential energy economy interactions and the simplified description of the realized GNP. In addition, as if that weren't enough, I would argue that that same model should also be the system integration module, that it should perform that function in that the macroeconomic part of the economy and the energy part of the economy should be linked up in a more intimate manner.

Let me say I'm very sympathetic to the notion of introducing reduced forms. If I had some additional resources to develop the work I'm doing -- which right now focuses on not only the second generation model but something we call the ICCAM, the integrated climate change assessment model, which has to do not only human activities but it also has to do atmosphere processes, it has to do climate change, it has to do ecosystem changes and those impacts back onto the national system -- you have a feeling that reduced form models look very attractive. As a consequence of that, we've spent a little bit of time working on those and it's amazing what you will find. Let me just get out of the economy for a moment and talk about oceans.

The frontier on oceans is three dimensional models that run on a Cray and they take a week to run. That's for the frontiers. For policy purposes, you can describe the atmospheric uptake of carbon with a single three-term compound exponential decay function. You can get almost the same behavior. Now, that drives natural scientists bonkers because it has no process, it just describes how the system works. But for a lot of purposes, that's all you really want. I've come to the conclusion that reduced forms are extremely useful tools if they can be constructed to capture the behavior that is the essence of the system of more sophisticated

## MACROECONOMIC ACTIVITY MODULE REVIEW

---

# WEAKNESSES

**It is energy SERVICES that matter, not ENERGY.**

**The present potnetial GNP description cannot describe energy-economy interactions through sectoral interactions.**

e.g. energy-agriculture interactions through biomass or carbon tax with reforestation offset.

## MACROECONOMIC ACTIVITY MODULE REVIEW

# OPINION

Ultimately there is a need for a new, ENERGY oriented macroeconomic model, with an enhanced description of the potential energy-economy interactions, and simplified descriptions of the realized GNP.

That same model should also be the System Integration Module.

NEMS
Workshop

## MACROECONOMIC ACTIVITY MODULE REVIEW

# USE OF REDUCED FORMS

Reduced forms are extremely useful tools, if they can be constructed to capture the behavior of more sophisticated systems, when the system in question is not the primary focus of the analysis.

systems when the system in question is not the primary focus of the analysis, and I think that's an important caveat. It can't be the primary focus. Of course you don't need to go to a reduced form if you have a simple fast executing process model in the first place. So, there are times in which it doesn't pay to do that. But when you have a fairly sophisticated process model which underlies all of this, then the attractiveness of the reduced form is that it allows you to get most of the answer. If the part of the system which is being run in reduced form is not the primary focus, then I think you're very well advised to go that direction.

The other thing which Andy mentioned this morning, and I think is very interesting, is that if well constructed those reduced forms can help you understand how -- for each one of those modules, how those modules interact and the relative importance of key underlying variables in the system as a whole.

That concludes my remarks.

PROFESSOR GRIFFIN: I'm Jim Griffin from Texas A&M and this is a happy day for folks in Texas following the Cowboys victory in the Superbowl.

I was particularly pleased when Ron called me several months ago and asked me to take part in this conference. You see, I wrote a series of papers back in the late 1970s and I thought that only two people read those papers, my mother who thought they were great, and G.S. Maddala who thought they were terrible. At that point, I thought that pseudo data and response surface modeling would forever lay there in these journals, never ever to be looked at. Lo and behold, the idea is alive and well at the EIA.

I thought what I would do today is spend a little time reviewing what prompted my early work and distinguish that between what's going on now at the EIA because there are some important differences and I think there's some things we can learn from that.

If we could, let's not turn the lights out completely because I don't know if you're like I am, but I tend to get pretty sleepy in these conferences. The original motivation for my work was I was at the University of Pennsylvania at the time the Wharton long-term macro model had just been developed. The idea was to develop a long-term macro model, an annual model with sectoral display, an input/output table, and so the usual relationship between final demands which were sought for in the main macro model and you have an input/output table. On the view graph, the I-A matrix where the A represents a matrix of technical coefficients, and X is your gross output. The obvious question is, given a solution for the final demands, what are the gross outputs by industry required to produce that?

So, the obvious question was, well, how do you model these $a_{ij}$ coefficients in the A matrix? If you think about this -- a column vector in this matrix represents the recipe for a given industry on how to produce -- if it's electric utilities, what are the inputs required to produce a kilowatt hour of electricity. These represent the inputs to produce the unit output of electricity. The question is, how is the best way to model these? At the time, a popular feature was to say, "Well, we don't want to just freeze these $a_{ij}$ coefficients in a Leontief technology. Let's allow them to respond to prices."

# EXHIBIT 1

I. Early Applilcations of Response Surface Modeling

1. How to make input-output coefficients ($a_{ij}$'s) of Wharton Long Term Model price responsive?

$$\begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} = [A] \qquad (1)$$

For any industry j:

$$a_{ij} = \frac{\partial(\frac{C_j}{Q_j})}{\partial p_i} \qquad (2)$$

translog unit cost function: (Hudson/Jorgenson)

$$\ln \frac{C_j}{Q_j} = \alpha_0 + \sum \alpha_i \, lnP_i + \frac{1}{2} \sum\sum \beta_{ij} \ln P_i \ln P_j \qquad (3)$$

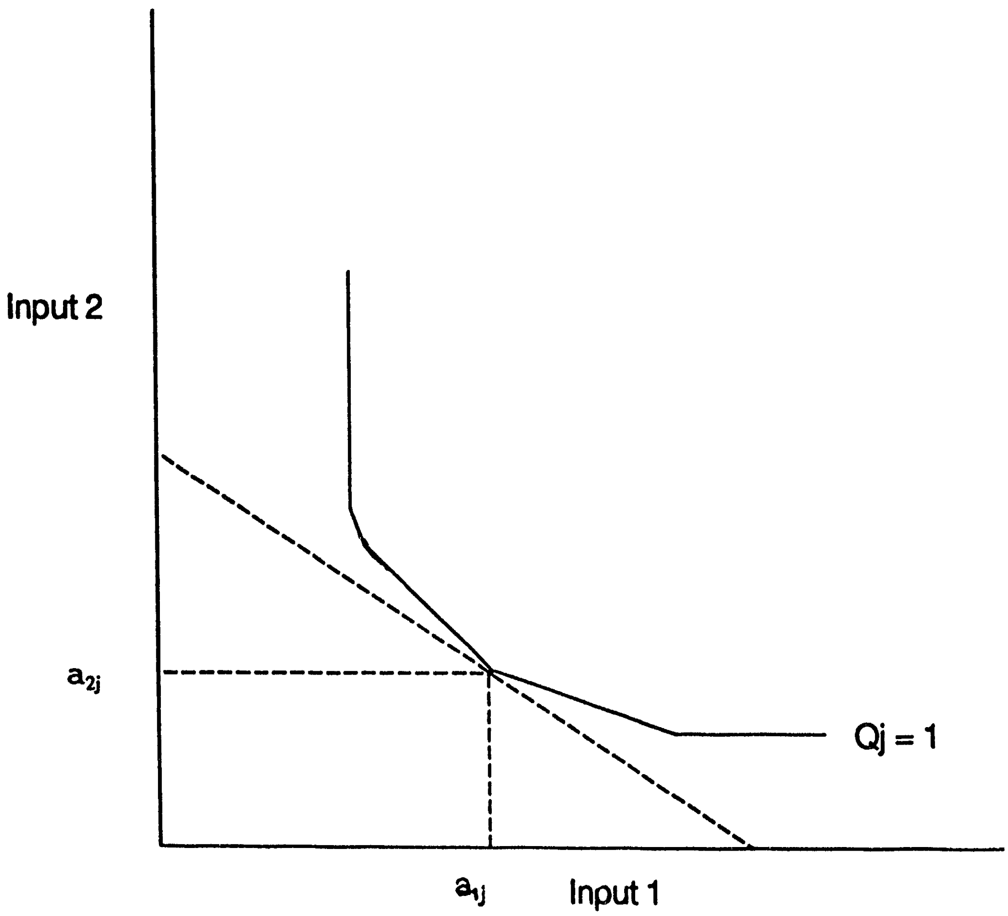
Do: $\hat{\alpha}_i$ and $\hat{\beta}_{ij}$ based on conventional time series data reflect long run equilibrium?

2. The Appeal of Industry Process Models

min $c^1x$

s.t. $Gx \leq b$ G is 200 x 350

**Figure 1.** Industry Process Model Approach



So, the obvious solution was--let's take one of the generalized functional forms, for example the translog unit cost function. If you knew the underlying parameters of this cost function, it was then simply a matter of differentiating this cost function with respect to the various input prices to obtain the $a_{ij}$, or input/output coefficients. That would allow these $a_{ij}$ coefficients to vary in response to prices.

So, then the idea was, "Well, let's take annual data and let's estimate these cost functions." The Hudson-Jorgensen model is a good example of that approach. At the time though, I thought it was a great idea in principle. My concerns were that annual time series data simply weren't rich enough to really give us the good sharp estimates of the underlying parameters of the cost functions. Additionally, for some of these industries where environmental emissions policies were changing rapidly, there was no historical basis in the past to reflect these changes. How could a historical time series possibly tell us anything about newly imposed sulphur oxide restrictions?

So, I wanted to go back to process models for a given industry. There are lots of process models out there for different industries. The basic idea of a process model is that you minimize the cost of producing a given output subject to a set of linear inequalities. These inequality equations may entail several hundred equations, which are solved by linear programming. For any given set of factor prices, you can solve out for the input/output or a $a_{ij}$ technical coefficients involved. For example, it solves for so much labor, so much capital, etc.

That was the basic idea. The question though is, how do you go about introducing an input/output model here of this dimension, an industry process model into the Wharton macro model? The problem was that there really is a two way linkage. You can't simply exogenize the industry process model because the model solution is conditional on a set of factor input prices. But with each iteration of the macro model. Prices change, necessitating a new solution to the industry process model. So, there's an interactive solution process going on here and you apparently face the dilemma, "Well, I've got to link the two models together because of the feedback problem."

It was here that we said, "Well, maybe there's a way around this -- if we could generate data from this linear programming model, use the pseudo data to estimate a cost function a la Jorgensen, then differentiate that cost function to obtain the input/output coefficients. Consequently, you end up replacing this large process model that might be 200 equations with a simple single equation cost function approximation of the process model. The cost function will then drive all of the input/output coefficients in the macro model. So, that was the motivation.

To summarize, our problem there was to build industry detail into the macro model. The problem you face here is just the reverse problem. The primary focus here is on the NEMS model and how do you build macro feedback back to the NEMS model.

Our second problem is we had a data compaction, a model compaction problem. We had these rather large process models. We already had a large macro model. To link the two industry process models directly with the macro model wasn't feasible. It seems like we've got the same problem here as well.

# EXHIBIT 2

3. The problem of linking The Industry Process Model with the Macro Model ⇒ TOO BIG!

4. Use of pseudo data to estimate unit cost function: Vary prices in process model, obtain a data set.

$$\ln\frac{C_j}{Q_j} = \hat{\alpha}_0 + \sum \hat{\alpha}_i \ln P_i + \frac{1}{2} \sum\sum \hat{\beta}_{ij} \ln P_i \ln P_j \tag{4}$$

Get $\hat{\alpha}_i$'s and $\hat{\beta}_{ij}$'s based on pseuda data.

5. Model column j of the input-output model with unit cost function, estimated from psuedo data where:

$$a_{ij} = \frac{\partial \ln(\frac{C_j}{Q_j})}{\partial \ln P_i} \tag{5}$$

In effect, the statistical cost function estimated with pseudo data from the industry process model enables the one-equation statistical cost function to serve as a response surface approximation to the 200 x 350 equation process model.

# EXHIBIT 3

II. Similarities and Differences with NEMS Approach

| **Early Work:** | **NEMS:** |
|---|---|
| 1. How to embed industry detail in a macro model | $1^1$. How to embed macro variables in an energy sector model |
| 2. Obvious data compaction problem | $2^1$. NEMS/DRI, a similar problem |
| 3. How to avoid simultaneously linking and solving two large models | $3^1$. Same |
| 4. Emphasis on translog cost function as the response surface | $4^1$. Best fitting, linear relationship |
| 5. Focus entirely on long run equilibrium | $5^1$. Explicit focus on modelling dynamics |

III. Thoughts on Response Surface Modelling and the increasing complexity of NEMS.

The other problem we faced is that we wanted to avoid having to formally link the two models together and simultaneously solve for the feedbacks back and forth between the two models. Of course that's exactly the motivation for your work here.

The fourth feature is that my early work adhered very strongly to this translog cost function. We used the translog as our "response surface." There's nothing magical about the translog. You can use any functional form. Ron Earley et al. basically work off simple linear functions and there's nothing wrong with that.

The fifth distinguishing factor in our approach was that we focused entirely on obtaining the long-run cost minimizing solution. It was a static type of application. Here, the application is dynamic. The NEMS approach wants to be able to solve not only for the long-run response of the macro model, but also the time path adjustment to it. I think that's interesting and innovative.

Just now from my own perspective, the way I summarize what's going on in the work that EIA is doing, I basically see a DRI model here of roughly 1100 equations. We've got a NEMS model of 1500 plus equations -- and I think we'd better emphasize plus because when I pressed Ron for exactly how big this model is going to be, all he could do was laugh. But he did say at least 1500 equations. So, we really do have a model compaction problem. Basically my interpretation of what they're doing, the way I would look at it -- is they use the DRI model to develop a baseline case. Then, what they're basically up to is they're saying, "Well, this is the one-way driver from the DRI model to NEMS." The question though is what are the feedbacks coming back the other way? Now, if there weren't any feedbacks, we wouldn't be here talking today. The issue would be settled. We could simply exogenize the output of the DRI model, feed it in as an input to the NEMS model, and that's the end of the story.

The problem though is what compensation do you make in a feedback from NEMS? For example, if we hit NEMS with a big price increase, the question is what feedback effects from NEMS would feed back upon the DRI model and affect GNP? So, what they're really doing is they're taking this baseline and they're modeling the delta Y, the feedback back from it. They've used pseudo data generated from the DRI model to fit functional forms here that model these changes.

What's my general assessment of all this? Well, I'm obviously pleased. I see some important similarities here to my earlier work, but I also see some important differences and innovations in their work. I like it.

My question is this: What role will response surface modeling basically play in this whole framework? It really -- so far the debate seems to focus on two issues. First of all, how good is the approximation? I.e., how closely does the response surface approximate the true surface? The second issue that seems to be driving the ultimate role of response surface modeling is what are the sizes and complexities of the models you're attempting to link together? Clearly, the more complex, the larger the size model, the bigger the necessity to go to response surface modeling.

I can actually visualize response surface modeling being used not just in this linkage between the macro model and the NEMS model. You can envision it being used extensively in NEMS, particularly if NEMS continues to grow in size, because just think about the NEMS model as the 12 submodules that Jay described. You can think about feedbacks, interdependencies among those. You can think about modeling those feedbacks between those different sectors using a response surface approach.

Finally, you can even visualize a PC version of NEMS which is based almost entirely on response surface modeling.

My own reaction to that is I think that the Director of Modeling Efforts at EIA might do well to apply the notions of emission rights to equation rights and actually create a market for equations and issue tickets for so many equations and make each modeling group within the 12 areas, make them trade rights to equations.

You know, there really are diminishing marginal returns to very large models. The ability just to debug, to understand where errors are coming from, gets increasingly difficult. The human mind can only handle fairly small systems. If you've ever worked at trying to debug an 100 equation model or larger, you find that it's really messy. Moreover, the knowledge that you obtained about the model, can't be readily passed along to the next person who comes in.

My fear is that by building a huge NEMS model that's attempting to answer all questions, we're going to end up with an unmanageable model. I'd like to see some types of constraints put on the system. I would like to see something that would run easily on a 486 machine and I think the way we're headed, that's not going to happen. For users outside of the EIA, it would be valuable to have a PC version of this NEMS model for grad students or anyone wishing to do policy type simulations.

In conclusion, I endorse the idea of response surface modeling. The use of response surface modeling should not give modelers a carte blanche for ever-increasingly large and complex models. I think that there are real limitations that ought to be imposed in terms of model size.

As far as Jay's idea of building yet a new macro model, that one hits me cold. The reason is that I don't think that EIA is particularly well suited to develop such a model. The folks at DRI have been in the macro modeling business for a long time. They've invested a humongous amount of resources. The model that they've developed is well documented, well detailed and I'd like to start with that as the basis.

Now, G.S., you're next. But remember, G.S., I've got a lot of powerful friends in Dallas.

PROFESSOR MADDALA: Well, the macro model is a DRI model. Anyway, the problem is NEMS needs some forecast from the macro model and the macro model needs some forecasts of energy inputs. As mentioned earlier by the previous discussants, the DRI model does not have enough detail on the energy sector and so on.

Well, what are the solutions? Solution A, link the two models, but this is not practical.

The DRI model has 1100 equations and the NEMS model has 1500.

Also, the macro model is not in the public sector. The DRI model -- well, this is an elephant and the NEMS model is an elephant. You can ride this elephant (NEMS) free. This elephant (DRI model) is very costly to ride and also the DOE is renting that elephant. So, they cannot provide that elephant to the public sector.

Then solution B is just to summarize some responsive surface -- that is summarize the macro model in terms of a few equations.

So, essentially the problem is you want to get a work horse out of this elephant (the DRI model). So, how to get a work horse out of an elephant is the question. Now, as far as I can see, if you want a work horse, you just go and get a work horse. Don't convert an elephant into a work horse. That's all I have to say. So, if that's all I have to say, maybe I should stop here.

Anyway, I'll give a little more detail. So the question is, what is the procedure being used for getting a work horse out of an elephant? So, how do you do this? Let's say the macro model actually has 200 equations (I didn't know exactly how big that elephant was). That elephant is bigger than what I described here. But let us say there are 200 endogenous variables, Y-1, Y-2, and 200 exogenous variables, X-1, X-2. What we are interested in is only some ten endogenous variables, denoted by Y-1, and ten exogenous variables denoted by X-1. That's the work horse we want.

How do you do it? Well, you just build a work horse. You just take those ten endogenous variables and ten exogenous variables and build a model. On the other hand suppose that you wanted to convert (squeeze) the elephant into a work horse? Then how do you do it? We simulate the macro model for different values of the ten variables X assuming that the other 190 exogenous variables X-2 do not change. Of course I have simplified the procedure, but essentially that's what it is. The generated data on Y-1 and X-1 form the pseudo data. Of course, instead of "pseudo data" you can use any other word for it. You can say, generated data or something like that. You can call it any name you want, but the general terminology that has been used is pseudo data.

Then we link it with the NEMS model. In the NEMS model Y-1 are exogenous variables and X-1 are endogenous variables. The situation is reversed for the DRI model. So, the fact is things that are exogenous in one model are endogenous in the other and things that are endogenous in one are exogenous in the other.

This sums up both the problems. Summarization of the macro DRI model, that is you have gotten a work horse out of the elephant and also solved that simultaneity problem because you are trading between the two models.

So far, so good. What's wrong? What's wrong is the use of those generated data, generated under the assumption that the other 190 exogenous variables are constant. Now, take a simple example of the regression equation Y equals beta-1, X-1 plus beta-2 X-2, plus U. What I want to communicate is the relationship between Y and X-1. What should I do? Well, the answer to this question is simple, just regress Y on X-1 and report it. The effect of X-2 on

Y is taken care of in the estimate of beta-1 and note that the expected value of beta 1 hat is beta 1, plus B-1,2, beta 2. B-1,2 is the matrix of regression coefficients of the excluded on the included variables.

Now, what is the alternative method? It is use the multiple regression equation to get predictions of Y, assuming X-2 constant. Then, from the generated data, you estimate a regression of the predicted Y on X-1. The thing is I don't know what use this is.

Well, my advice is the following. Forget about pseudo data. It's a waste of time. Estimate the model you want with actual data. This is no more atheoretical than the pseudo data. My second advice is dump the DRI model.

Now, the thing is, as I said at the beginning, you have these elephants but you want work horses too because with the elephants all you can have is a circus show. Alexander the Great invaded India and fought a war with a king there. That king went into the war on his elephant. So, you know what happened. Alexander had a cake walk. So, the thing is that elephants are for some special purposes and work horses are for general purposes. You can't use an elephant as a work horse. So, along with the elephants, you need work horses too.

The NEMS model is a big elephant. It has also some subcomponents, each of which is an elephant. Now, it's a waste of time to get a work horse out of this elephant in an artificial manner. What you should do is just have a work horse side by side. Getting a work horse is cheaper, requires less work and is more straightforward than trying to squeeze the elephant into a work horse.

Now, finally, the question of simultaneity. The question is can simultaneity be taken care of by iterating between models? I have some reservations on this. Again, for simplicity, suppose we have two simultaneous equations, with Y-1 and Y-2 endogenous. Start with some values of Y-2, estimate the equation for Y-1, get Y-1 hat, substitute it in equation two, estimate the equation for Y-2, get Y-2 hat, go back to equation 1, substitute Y-2 hat and keep on iterating.

Now, Hermon Wold suggested this procedure actually, but he called it NIPALS procedure in the early 1970s and also wrote a book on that. I reviewed that book. I don't know where the review was published. I don't recall, but I gave examples of multiple kinds of convergence and Wold got mad at me but nobody paid that much attention to Wold or me. So, everyone forgot about it. I forgot about it too because I don't remember where I reviewed it. But now I see it being resurrected in another form. I never thought about this problem for the last 20 years. So, in short, I do not think that iterating between models is a correct method of dealing with simultaneity.

That's all I have to say.

MR. PEABODY: Thank you very much.

We have 40 minutes for discussion and questions. So, who wants to be first? Can you pass the mike around? The speakers could come back up here.

MS. YANCHAR: Hi. I'm Joyce Yanchar from DRI, so I do have a few comments to make.

First, I think of the DRI model not as an elephant, I guess, but more as a stallion. We have developed smaller scale models to try and get away from this notion people have that it's a non-manageable model to work with. Really with the smaller scale models, we've found, one, that the simulated properties were not as good as the large scale model, as far as standing up to what we theoretically feel should happen.

And two, in using the models, they were much more difficult to use because they did not have the levers. They did not have the variables that we needed to alter for a wide range of policy analyses. So, it really made it a lot more work for the user outside of the model to get the inputs ready to put into the smaller model to simulate it. We feel that the size of the model we have now is optimal for most of our analyses, that any larger is probably unnecessary. It may be carrying around more weight than we need to carry around and any smaller we're giving up something in terms of properties or something in terms of ease of modular use.

Then, with respect to Jay's comment, I have to say that Jay, I think, was asking for a larger model and he is certainly suggesting a very simple supply side for a model. I do want to remind Jay that this is a macro model, but our supply side is not just that one equation. I think when you put out that one equation, you're ignoring all the detail in that model with respect to capital accumulation, for example, the effect of interest rates, monetary policy and interest rates on capital accumulation, tax policies, R&D investment, the lifetimes of a wide range of equipment, not just one aggregate capital stock.

I think you also suggested instead of using -- you have to remember that energy is in this model, but we do link up with a full scale energy model. So, we do have a representation of energy. When we are doing that linkage, certainly for some policies, just looking at Btu's of energy and their effect on potential GNP is simplistic. But with a link with another model, you do have more information about the energy services being provided and what that impact is on potential GNP. I would say that the aggregate equation is a very handy equation to keep some kind of perspective on what kind of growth is capable for the economy. If you start running large growth risks from your policy, I think you should question those against what your labor supply is, what your capital accumulation is and what your energy is, which is just five percent of your potential to produce.

So, keep things in perspective. It is a macro model and there's a lot to be learned from an aggregate equation. Certainly in some policies, as I said, we do take into account the fact that just a reduction in Btus of energy does not necessarily reduce potential GNP if we're able to maintain our energy service. That's where the sophistication on a modeler's part comes in, to offset some of the aggregations of the supply side.

Jay also suggested using energy services rather than energy in the equation and I guess I would have a question--how does one take out -- energy services are provided by capital labor and energy, I would imagine. How would you then differentiate what part of labor and what part of capital is associated with that energy versus the non-energy component. I don't think we have data on what part of the structures is a sign to the thermal integrity of the stock. So, an aggregate equation is putting all of that capital into one where we don't really have information to split it between energy and non-energy. So, it's a much bigger problem, I think, than should be addressed in a macro model.

MR. PEABODY: Thank you.

Next? Do you want to respond?

DR. EDMONDS: Just a couple of points of clarification. One is that my comments were not intended to be a blanket condemnation of the DRI model by any stretch of the imagination and I hope you didn't take it as a general criticism. In fact, it is a well-respected, and I respect it, a well-respected model.

My comments had more to do with the issue of -- they have a phrase in the U.K., different horses for different courses. That is making models into uses to which models are put. Match as best you can. I think we've talked about this around the edges and I think all the comments had something to say about it. Let me just bring it up in a straightforward manner. I think the point we're all talking about is how do you get the best tool for these three functions that have been outlined for the U.S. economy model within the National Energy Modeling System. My comments really -- where I came down was that because the DRI model was developed for a lot of different purposes, many of which are only tangentially of interest to the energy system, and therefore I think there is significant potential for aggregation if the critical questions are energy-related questions and you don't really want to get into the details of the rest of the economy. You may be perfectly happy to live with two digit or even higher aggregations of the manufacturing sector.

With regard to the -- I didn't want to get into the full breadth of the supply side of the DRI model because, as you correctly point out, in fact some of the most interesting and important features have to do, particularly in the tax recycling question, with how the capital market generates capital. In fact, ultimately that's what you want to pay attention to rather than the supply side. If you really cared about the energy problem and you really cared about extending the model out into the long-term, then in fact the supply side probably was too -- in this case, was not sophisticated enough. It was not rich enough. It didn't have enough detail.

So, what I was suggesting in my opinion at the end was that if you were going to think about the NEMS modeling structure from the start with a completely blank slate and say, "What do I really want?" then my comment was that you probably want a macro model that doesn't have quite as much detail on the demand side and more detail on the potential GNP side and in that sense was a reconfiguration of the --well, was a different model and one that was structured for the particular requirements that EIA now faces, which is going from annual all the way up to 50 years. So, that's a fairly wide swath of time.

So, I hope that clarifies the comments I made.

MR. RICHARDS: Gordon Richards from National Association of Manufacturers. I'd like to put the following question to G.S. Maddala. He recommends the use of the vector autoregression as an alternative to the use of pseudo data, but it seems that there would be two inherent problems with the use of the VAR-type model. The first is that VARs were not designed to actually make sure the elasticity isn't one variable with respect to another, but in fact designed to measure everything in terms of theoretical distributed lags on all the variables.

The second problem with the VARs, of course, is that they become unmanageably large much more rapidly than standard econometric models do, with the result that the only way to make it more effective is to curtail the number of variables. That raises the following issue. If you're using a bar and you have to omit certain variables from it, the bias implied by variable omission may well exceed the bias implied by simultaneity that Professor Maddala was addressing.

I'd be very interested to hear why he prefers to use a VAR in spite of these inherent drawbacks.

PROFESSOR MADDALA: I just used the word VAR because that was what was being done in the paper I had read about how the condensation was done. In fact, after generating the data, the equations that were estimated were the VARs. So, what I was saying was why not do it directly with observed data rather than pseudo data? I'm not saying that VAR is the only one that you should be estimating. Whatever it is you want to do, do it with the real data and not with pseudo data. So, it's not that I'm advocating VARs.

MR. EARLEY: Let me make a couple of comments. I'm basically here to listen at this point, but I think a couple of comments on my part would be useful, particularly with the VAR. That was in a paper that we wrote a year before this process began. We started looking at alternative ways to deal with the problems that we saw facing us and constructing the NEMS and particularly, from my point of view, the macro side of NEMS. We considered VAR. But the point that you just raised was one of great concern.

One of the things that, of course, happens in the process of building a model is it's a moving target. That's fine as a lot of the individual modules are concerned because they may be receiving information from one other module primarily. But what happens on the macro side is that everybody, everybody needs something from macro. So, what that means is we've got to be extremely flexible in the modeling system in order to be able to add anything at a drop of a dime to give someone another variable that they need for their model.

So, the response surface mechanism, one benefit to it is you have a large structural model that's at your disposal. You're going to be generating the pseudo data in a very structured way. You just save all of those simulations. You have that database there. Then if someone needs an additional variable, you can basically extract out of that and generate a set of feedback elasticities that are consistent with that model structure that you've got and you can go off in that direction. So, the size issue is one concern there.

The other point is -- let me pick up on a point that Joyce made. This is a comment about some of the work that we have done with DRI, but it's also a comment that I know in terms of working with other groups. This is just a word of caution as well. That is, when you take a large model and then you try to build a small version of that same model, the one thing that you've got to be careful about is are they going to have different simulation properties? You've got to always be aware of that because one of the issues is that you may end up with two models that have two implied sets of elasticities there and you're doing a large structured analysis with a large model and then all of a sudden at the drop of a dime you're asked to do a quick and dirty overnight with your smaller model and it's going off in a different direction. I'll tell you, in Washington that's the quickest way to doom -- to give two answers to the same question one night and then the next morning.

So, one of the ways the response surface helps you out is that you can feel comfortable that the answer that you're giving through the response surface, quick turn around answer that you may have to give, is going to be compatible with the larger structure model that you're going to do. If it isn't, you've obviously done something wrong in terms of generating the pseudo data of the response surface model to begin with. But it's a real concern to have two different versions of models floating around giving two different types of answers to the same question. You want to be internally consistent as best you can.

But to pick up on Andy's point, this is not to say that the response surface model is going to give you absolutely precisely the same answer in the same time profile. It's going to smooth things or it's going to lope along through your solution of your larger model and in a very general sense you hope that your econometrics and your design of the building of the model is such that if you've done the job pretty well that you'll be able to replicate those behaviors of the larger model a little bit better.

At this time, I just want to show you one set of slides and then I'll open it back up. I will say this. Beauty is in the eye of the beholder. I've never wanted to own an elephant. Sometimes I'd like to ride one maybe. So, renting a ride on an elephant is fine.

We did a simple experiment. This is the world oil price path of the NEMS -- I call it NEMS. Basically this is the existent -- correct me if I'm wrong -- the AEO price path that we have in this year's Annual Energy Outlook. Then all we did was a 20 percent increase in the world oil price and we said the idea behind the experiment is okay, what happens?

I'm going to show you this graph. This is the impact, the percent loss in GDP associated with that 20 percent increase in the real world oil price. The red line represents how our response surface version of our coefficients, the way they are right now, basically behave and the DRI model simulation is the green line. Now, in fact, this is the sum of GDP components. What we have done is we've generated this for all the components of final demand, had separate equations for all those components of final demand and then we've aggregated the deltas that happen up into a sum of GDP. We also have an equation that is GDP straight, but it's our feeling that the sum of the GDP is really the better measure. In fact, the GDP equation tracks very closely to the red line as well.

Now, like I said, beauty is in the eye of the beholder. When you aggregate this over all of the final demand changes and into this sort of relationship, I viewed this as doing a reasonably good job of tracking the response of the DRI model. In fact, if you just do some sort of generalized kind of log elasticity of the impacts here over this time frame, we've done some calculations and basically the elasticity, when measured over this entire time frame, is literally the same.

Let me show you one other graph. This will get back to Jay's point and, I think, Joyce's point. Let me separate out the lines, the red and the green, what I just had on there before. The other two lines, the starred line is the response surface version and the boxes are the DRI. Now, this is the full employment potential of GDP equation that exists in DRI. It is, as we've described, a single equation but it's a big equation and it takes in movements in labor, capital, energy. One of the features that we see happens here is that when you impose a price shock on the economy, the DRI model shows that there is an initial adjustment cost to the economy, but then it responds back towards the baseline. The other two lines essentially show what's happening to the full potential output of the economy and basically it goes down over time.

The one interesting feature of this, it is -- believe me, we didn't plan it this way, but the red line and the starred line come together by 2015. What this says is you've got a long run impact on the economy that affects the potential output of the economy, but you also have to absorb some adjustment cost in the process of getting there. You would expect that over the long run, depending on what happens to potential GNP, that eventually all these adjustment of costs will play out and you would hope that you would fall into some sort of the long-run equilibrium again sometime out in the future. Now, you can debate how far out this is, what the magnitude of the loss is, but this should be a feature of what the models exhibit.

This is a bottom line graph. To just show you one other graph, it's the change in the unemployment rate coming from this. So, we've got some other graphs. I've probably, in all honesty, tried to show you some of the better ones. I'm not going to pull the wool over this audience's eyes. But this is the performance of the respond surface as we are now folding it in and we're aiming this big ship towards docking sometime here in April.

But I thought in the light of the conversation that just happened this might be a useful way to get you to think about what the response surface is, in fact, doing relative to the performance of the larger structural model.

DR. ELIAS: Tom Elias from the Department of Energy, Idaho Field Office.

How is the NEMS model compared with the National Energy Strategy Model?

MR. PEABODY: FOSSIL2.

DR. ELIAS: FOSSIL2.

MR. PEABODY: FOSSIL2 Model has a totally different structure. It's built on a system of differential equations and they try to represent a lot of the same detail that's in NEMS. But it's a totally different approach.

DR. ELIAS: But that also uses the DRI model as the base model, I suppose.

MR. PEABODY: They use outputs from the DRI model as exogenous inputs, but there's no direct linkage.

MR. EARLEY: They use the macro baseline that I give them and that's what they put into IDEAS, FOSSIL2.

MR. SANTINI: Dan Santini, Argonne National Labs. Question about the material just presented. Is there a response of world oil price in future years as a result of that 20 percent shock or just simulating a 20 percent shock maintained for the full projection period?

MR. EARLEY: What we just showed there was a very rigid experiment only using the macro model, just presuming that the world oil price went up by 20 percent. We're not attributing any causal -- how that comes about, we're just saying it happens. Given that, we want to know what the response is in the macro economy.

Let me respond a little bit further on that because the IFFS system, which is currently what EIA runs, has an exogenous world oil price and essentially an exogenous international market. So, the new system of NEMS will have an internalized international market. So, when there is a change in energy markets domestically and quantities go down--let's say there's some sort of a tax imposed which changes quantities--to the extent there's any change in domestic markets, it will have an influence on international markets and there will be internal feedback now on the world oil price internal to NEMS. So, that is one, I think, major improvement of this system over the previous system where all of that was dealt with exogenously.

MR. TROST: I'm Bob Trost from EIA and George Washington University.

The point you were making that if you leave out the Xs there will be biases is correct, but I think if I understand the point Professor Maddala was trying to make, it is that if you use actual data it's true, you can leave out some Xs and you get bias, but at least the effect of those Xs on the Y that you leave out will be felt through the correlation to the Xs you left out and the Xs you include. So, to some extent you're capturing the effect of those Xs because they are allowed to change with actual data, whereas the pseudo data, when they generate them, those Xs are held fixed throughout the experiment. So, the point I thought was true, when you leave Xs out there are biases, but at least you're getting some effect of those on a Y because of the correlation between X-1 and X-2, and the pseudo data you're not.

So, it's really an argument for using actual data to get the work horse and not pseudo data. That was, I think, the point.

AUDIENCE: (Speaker off mike.) Well, the theoretical is easy enough to understand, but I don't think anyone can resolve empirically whether or not an omitted bias in the VAR exceeds some of the bias in a structural model. It would be interesting to take a look at that.

MR. TROST: That is another question. His point was using the pseudo data versus actual data, period, I think.

MR. SANTINI: Dan Santini again. From the earlier discussion about the equation, potential GNP equation Jay Edmonds put up, it seems to me that there should be a separation of the capital stock into energy-intensive capital stock or that part of the capital stock which would be estimated within the NEMS system. I presume that the way that NEMS is generating some of the changes in potential GNP is through capital stock effects from the separate sectors. It's unfortunate that the data are so poor that DRI has been unable to break those categories out in the past. I think it would be an improvement if it were possible.

MR. EARLEY: I'll just nod my head up and down.

AUDIENCE: What kind of breakdowns are you talking about? We do break down certainly public utility investment in mining and petroleum structures. I think what Jay was calling for was more than that.

MR. EARLEY: Let me just put it this way. We've got a number of supply models. Let's just focus on supply right now. Over half of the system is dealing with not only utilities but also what's going on with refineries. Some of the measures that may be talked about in a policy context over this midterm period may have some fairly extensive capital requirements. I guess just given the general comments, what we should do is try and strive for just more specificity, a little bit more detail to be able to capture those sorts of capital needs internal to the modeling structure.

That's going to be one of the problems that we're going to have to wrestle with. For example, how you deal with pollution abatement equipment. We're going to have to come to grips with that. One view of pollution abatement equipment is that it's a command for resources. It's a command for capital, but it's inherently non-productive and that actually represents a drain. It's a requirement for more capital resources, but to the extent it doesn't feed directly into the potential GNP equation. What do you call pollution abatement equipment and how do you designate what is and what is not productive equipment, particularly in the context of this energy debate? To carry even that argument a little bit further, it's a little presumptuous to call something non-productive when, in fact, if you can think about it from an environmental point of view, there may be some benefits elsewhere by virtue of reducing or putting on scrubbers and reducing emission elsewhere that may have a benefit elsewhere in the economy.

Trying to come to grips with some of these capital issues I personally think is one of the thorniest things that we've got to try to get a handle on.

Jim?

PROFESSOR GRIFFIN: Well, I thought that G.S. might have mellowed in his old age, but I find that he's every bit as tenacious as he was back in the late 1970s.

G.S., I want to make one statement and then I have one question. My statement is that I think we've lost sight of the really important issue here. The issue is not simultaneous equation bias. The real issue is how close an approximation can pseudo data make to the output of the macro model? That's the basic empirical question and I think that the only way we're going to resolve that was with the types of examples that Ron put up on the view graph. You look at those and say, "Well, is that good or bad?" That's my statement.

My question to you is this. If we're going to get rid of the DRI elephant, what are we going to replace the DRI elephant with? What does your work horse look like? You've told us now it's not a VAR model. Exactly what does it look like? Who is going to develop it? Who has the expertise? Give us some of the details on what it is going to look like. Thank you.

PROFESSOR MADDALA: It seems the question of how close an approximation, whatever you have is --I thought I said it was not a relevant question. The thing I was complaining about is trying to approximate. Approximate for what? You should ask why you want to approximate. All I was saying was that it's a futile attempt to try to approximate the DRI model for multiple purposes. It is always best to build your own model. Why do you want to ask the question, "Is this a good approximation?" It's like asking the question, "How good is this horse I have as an approximation to an elephant?" That was my full point. So, I don't understand what the issue is.

So, the thing is that here you want something, you want a small model with ten exogenous variables that you want to use for general purpose. Now, why should I ever think of it as an approximation to that equation with 200 variables and so on. So, I don't understand that question.

See, when you want to talk of approximation, first of all you have to ask the question, "What is it I want to approximate? Why should I approximate and for what purpose?" So, it's a question that can never be answered without stating the specific purposes.

PROFESSOR GRIFFIN: Well, let me try to clarify the question.

PROFESSOR MADDALA: I think this was the issue I was trying to clear up over ten years ago. I thought the issues were laid to rest since nothing more happened. In fact, as far as I can see nothing more happened on this approximation issue for the last ten years. Again, it has been resurrected and at that time I knew that it was futile to talk of approximation unless you are perfectly clear what it is you are trying to approximate, and why? See, the question is do I start with a huge model for everything and use the same approximation for every purpose? What I'm saying is that for some purposes maybe you need that huge model, but for many purposes you want some small models. You should never try to approximate the big model into a single small model. It is like squeezing a big elephant into a small work horse. You should never do it.

I have here a general message and that is that along with all these elephants, you should have some work horses side by side when it's a question of how far you want to ride, where you want to ride and all that. So, I think the approximation issue is an irrelevant thing in my opinion. It's completely irrelevant. It's an irrelevant question.

PROFESSOR GRIFFIN: It's not an irrelevant question --

PROFESSOR MADDALA: That is if you want to use this big model for every purpose. Here I want to make one point. For each particular problem, there would be a smaller model.

PROFESSOR GRIFFIN: Just tell us what this ten equation model is going to look like of the macro model that's going to be used to drive NEMS? That's all I'd like to know.

PROFESSOR MADDALA: I think Dr. Edmonds has said that the DOE should build its own model incorporating these interactions. I think I agree with that particular view, if I understand what he is saying. We'll never agree because the question you are raising (of approximation), I think, is irrelevant. That's what I'm saying. In fact, that was the whole message of my talk, that irrelevant questions are being asked and a lot of time is wasted in asking irrelevant questions.

I think the first thing, most important thing, is to think what's the problem. It is futile to think that every problem can be solved by a single approximation of a big model. I don't know what else I have to say.

DR. EARLEY: I think Louise will have my head if I don't let everybody go to lunch so they can be back at 1:00. I want to thank you and I really do encourage you to get involved in this process, not just in the macro model but get involved in the rest of NEMS.

Let your views be felt and we're here to listen to your comments and to help you become better users of the system when it's finally implemented.

So, with that, feel free to call me. Call Andy, call Mary. We'll be glad to talk to you.

I want to say thanks again for the reviewer's comments. I do appreciate them all.