Partnership for Economic Policy

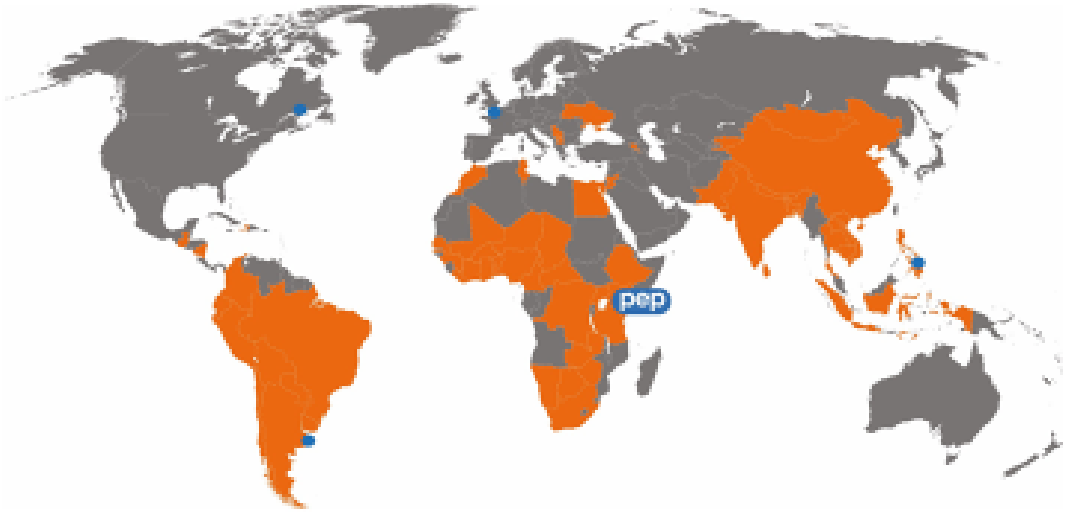
Martín Cicowiez (CEDLAS-UNLP)
Bernard Decaluwé (Université Laval)
Mustapha Nabli

What is PEP

Capacity building for research and policy impact

A global organization to build local capacity in providing contextualized policy solutions

PEP supports high quality and policy-engaged research in developing countries



287 projects &
950 researchers in
61 countries

1/3 projects results in findings taken up to influence policy

1/7 results in peer-reviewed journal publications

1/3 focuses on gender issues

PEP objectives and strategy

Build/strengthen local capacity for…

high quality research

policy outreach & advocacy

Produce new and reliable evidence to inform country-specific policy issues

Promote visibility/influence of local expertise, both at national and international levels

Strengthen or **create new research-policy linkages**

Research groups – methods

Community-based monitoring system (CBMS)

Macro-micro policy modeling

Microeconomic analysis & non-experim. impact evaluations

Experimental research - RCTs or field experiments

partnership for economic policy

pep

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Policy Optimization with a CGE Model

Martín Cicowiez (CEDLAS-UNLP)
Bernard Decaluwé (Université Laval)
Mustapha Nabli

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Motivation

- Usually, CGE models used for “shock analysis” $\rightarrow$ either exogenous shock(s) or change in policy variable(s) and compute model results.
- However, we can also perform “optimal policy analysis”, even for relatively large models
  - specify objective function and compute optimal values for selected policy variables
  - CGE model operates as the constraint of the optimization problem

Policy Optimization

$$\min L = \sum_i \phi_i \left(\frac{x_i}{x_i^*} - 1 \right)^2 \qquad \text{s.t. } F(x, u, z, \mu)$$

where

L = loss function

x_i = endogenous variables

u_j = policy instruments

x_i^* = policy objectives (x^* is subset of x)

u_j^* = u_j in base

z = vector of exogenous variables

μ = vector of parameters

Literature Review

- Optimal Taxation
  - Böhringer and Rutherford (2002) static multi-country CGE model to determine optimal environmental tax
  - Bovenberg and Goulder (1996) similar analysis for the United States
- Kim (2004) linear CGE model in the context of a stochastic control problem that incorporates the uncertainty about the value of certain parameters of the model.
- André et al. (2012) implement multi-criteria decision making to estimate efficient trade-off between inflation and unemployment rate (Phillips Curve).
- Our Contribution: develop general approach to policy optimization with CGE and provide three possible applications.

Implementation in PEP-1-1

- To implement the policy optimization approach, we extended the PEP-1-1 CGE model (Decaluwé, Lemelin, Robichaud, Maisonnave, 2013)
  - small open economy CGE model
  - + unemployment through wage curve
- As an example, we show three applications over a dataset for Argentina in 2012
  - Optimal Policy Response to a Negative Shock
  - Optimal Selection of Macro Closure Rule
  - Policy Optimization

The Argentina Model and Data Disaggregation

- 4 factors: labor, capital, land, other natural resources
- 17 activities and commodities (not 1-1 mapping)
- 1 household
- Other institutions: government and rest of the world

1. Optimal Policy Response to a Negative Shock

- Negative Shock : 50% decrease in world export price of agri-food.
- Two objectives :
- Employment level
- Real government deficit
- One policy instrument :
- Government consumption

Optimal Policy Response to a Negative Shock

$$\min LOSS = wt_{UERAT}\left(\frac{UERAT}{UERAT^{*}}-1\right)^{2} + wt_{SG^{REAL}}\left(\frac{SG^{REAL}}{SG^{REAL,*}}-1\right)^{2}$$

s.t. all equations in the CGE model

With UERAT*=UERATO and
SG_REAL*=SG_REALO

Normalization of Policy Objectives

First, solve two single-objective optimization problems to compute pay-off matrix of unemployment vs. real government savings; i.e.,

$$\min LOSS = wt_{UR}\left(UERAT/UERAT^{*} - 1\right)^{2}$$

s.t. all equations in CGE, 50% decrease in world export price agri-food, gov con as policy instrument

$$\min LOSS = wt_{RGS}\left(SG^{REAL}/SG^{REAL,*} - 1\right)^{2}$$

s.t. all equations in CGE, 50% decrease in world export price agri-food, gov con as policy instrument

Normalization of Policy Objectives: Pay-Off Matrix; Unemployment vs. Real Government Savings

case	UERAT (%)	SG_REAL (LCU)
base	16.50	25.7
weights		
UERAT=0	**18.40**	25.7
SG_REAL=1		
weights		
UERAT=1	16.50	**-123.0**
SG_REAL=0		

Normalization of the Loss function

We start with

$$\min LOSS = wt_{UERAT}\left(\frac{UERAT}{UERAT^{*}} - 1\right)^{2} + wt_{SG^{REAL}}\left(\frac{SG^{REAL}}{SG^{REAL,*}} - 1\right)^{2}$$

To get

$$\min LOSS =$$

$$wt_{UERAT}\left(\frac{UERAT - UERAT_{\min}}{UERAT_{\max} - UERAT_{\min}}\right)^{2} + wt_{SG^{REAL}}\left(\frac{SG^{REAL} - SG^{REAL}_{\min}}{SG^{REAL}_{\max} - SG^{REAL}_{\min}}\right)^{2}$$

NON optimal Policy Response to a 50% decrease in world export price of agri-food

- Closure rules :
  - Real government expenditure is fixed
  - Current account balance in FCU is fixed
  - Investment is saving driven
  - The real exchange rate adjust to clear the Current account balance.

NON optimal Policy Response to a 50% decrease in world export price of agri-food

			weights in loss fn		
		non-	UERAT=0	UERAT=0.5	UERAT=1
	base	opt	SG_REAL=1	SG_REAL=0.5	SG_REAL=0
Item	(1)	(2)	(3)	(4)	(5)
Private consumption	1,829.3	1,786.6	1,781.1	1,791.7	1,803.0
Private investment	473.5	415.9	449.2	387.3	326.2
Government consumption	417.1	417.1	382.6	446.0	505.0
Exports	428.1	375.8	381.4	371.0	361.0
Imports	379.3	314.5	319.7	310.1	301.0
GDP at factor cost	2,371.8	2,345.2	2,337.0	2,351.7	2,364.0
Real governement savings	25.7	-13.7	25.7	-48.0	-123.0
Current account balance	-11.30	-11.30	-11.30	-11.30	-11.30
Real exchange rate (index)	1.000	1.012	1.017	1.008	0.999
Unemployment rate (%)	16.50	17.89	18.40	17.44	16.50
Loss	0.000	0.000	0.000	0.245	0.000

NON optimal Policy Response to a 50% decrease in world export price of agri-food

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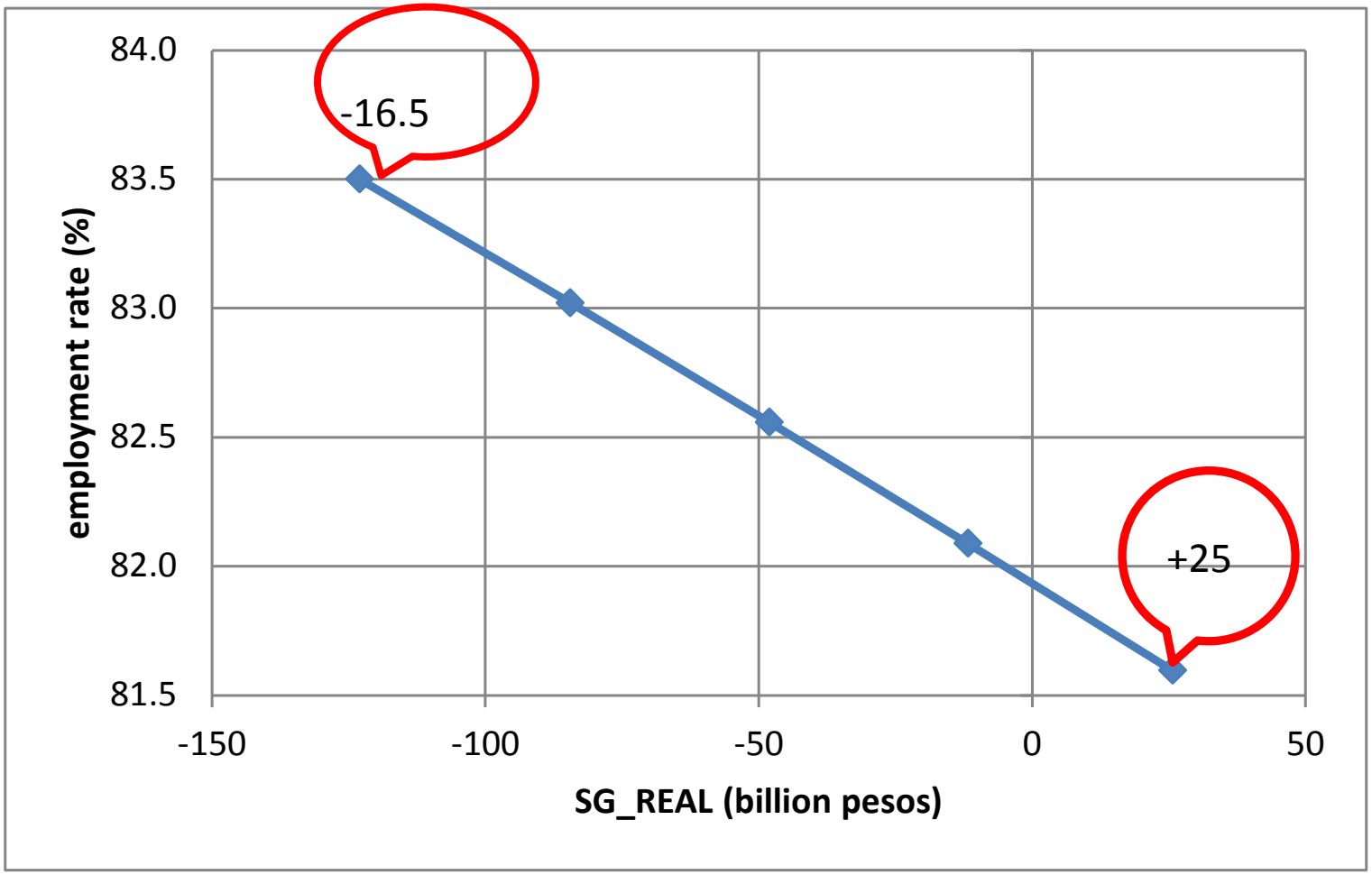
Optimal Policy Response to a Negative Shock; trade-off between employment and government savings



2. Optimal selection of Macro closure rule : Trade liberalisation

- The scenario : Elimination of all tariff.
- Two objectives :
- Gross Fixed Capital Formation GFCF
- Current Account Balance
- One policy instrument :
- Foreign versus domestic financing of the goverment deficit.

NON optimal selection of Macro closure : trade liberalisation

- Closure rules :
  - Real Government consumption is fixed
  - Current account balance is fixed
  - Investment is saving driven
  - Real exchange rate is endogeneous.

NON optimal Selection of Macro Closure :Trade liberalisation

			weights		
			CAB_FCU=0	CAB_FCU=0.5	CAB_FCU=1
	base	non-opt	GFCF_REAL=1	GFCF_REAL=0.5	GFCF_REAL=0
Item	(1)	(2)	(3)	(5)	(7)
Private consumption	1,829.3	1,841.2	1,841.7	1,841.4	1,841.2
Private investment	473.5	471.2	473.5	472.4	471.2
Government consumption	417.1	417.1	417.1	417.1	417.1
Exports	428.1	440.4	439.1	439.8	440.4
Imports	379.3	391.8	392.9	392.3	391.8
GDP at factor cost	2,371.8	2,378.2	2,378.6	2,378.4	2,378.2
Real governement savings	25.7	14.7	14.6	14.6	14.7
Current account balance	-11.3	-11.3	-13.8	-12.6	-11.3
Real exchange rate (index)	1.0	1.0	1.0	1.0	1.0
Unemployment rate (%)	16.5	16.1	16.1	16.1	16.1
Loss	0.0	0.0	0.0	0.2	0.0

2. Optimal Selection of Macro Closure Rule

$$\min LOSS = wt_{GFCF^{REAL}} \left(\frac{GFCF^{REAL} - GFCF^{REAL}_{\min}}{GFCF^{REAL}_{\max} - GFCF^{REAL}_{\min}} \right)^2$$

$$+ wt_{CAB^{FCU}} \left(\frac{CAB^{FCU} - CAB^{FCU}_{\min}}{CAB^{FCU}_{\max} - CAB^{FCU}_{\min}} \right)^2$$

s.t. all equations in the CGE model

Optimal Selection of Macro Closure Rule

			weights		
			CAB_FCU=0	CAB_FCU=0.5	CAB_FCU=1
	base	non-opt	GFCF_REAL=1	GFCF_REAL=0.5	GFCF_REAL=0
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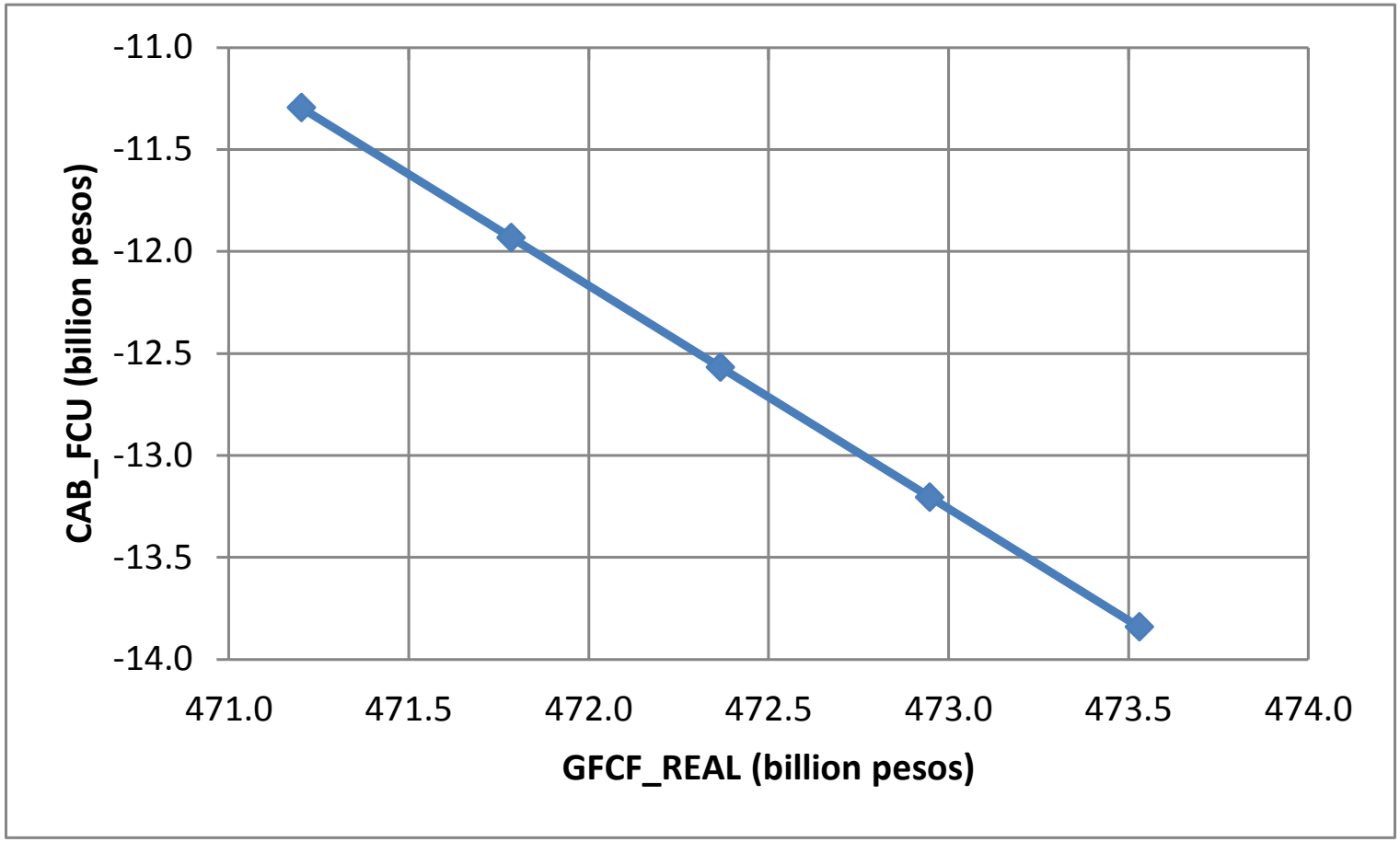
Private investment	473.5	471.2	473.5	472.4	471.2
Government consumption	417.1	417.1	417.1	417.1	417.1
Exports	428.1	440.4	439.1	439.8	440.4
Imports	379.3	391.8	392.9	392.3	391.8
GDP at factor cost	2,371.8	2,378.2	2,378.6	2,378.4	2,378.2
Real governement savings	25.7	14.7	14.6	14.6	14.7
Current account balance	-11.3	-11.3	-13.8	-12.6	-11.3
Real exchange rate (index)	1.0	1.0	1.0	1.0	1.0
Unemployment rate (%)	16.5	16.1	16.1	16.1	16.1
Loss	0.0	0.0	0.0	0.2	0.0

Optimal Selection of Macro Closure Rule; trade-off between GFCF and CAB



3. Policy Optimization :Minimize unemployment rate

$$\min LOSS = wt_{UERAT}\left(\frac{UERAT}{UERAT^{*}}-1\right)^{2} + wt_{SG^{REAL}}\left(\frac{SG^{REAL}}{SG^{REAL,*}}-1\right)^{2}$$

s.t. all equations in the CGE model

Policy instrument :government consumption

Objective : minimize unemployment rate

UERAT*=8.25 % reduce the unemployment rate to 8.25 % (a reduction of 50% with respect to the base year).

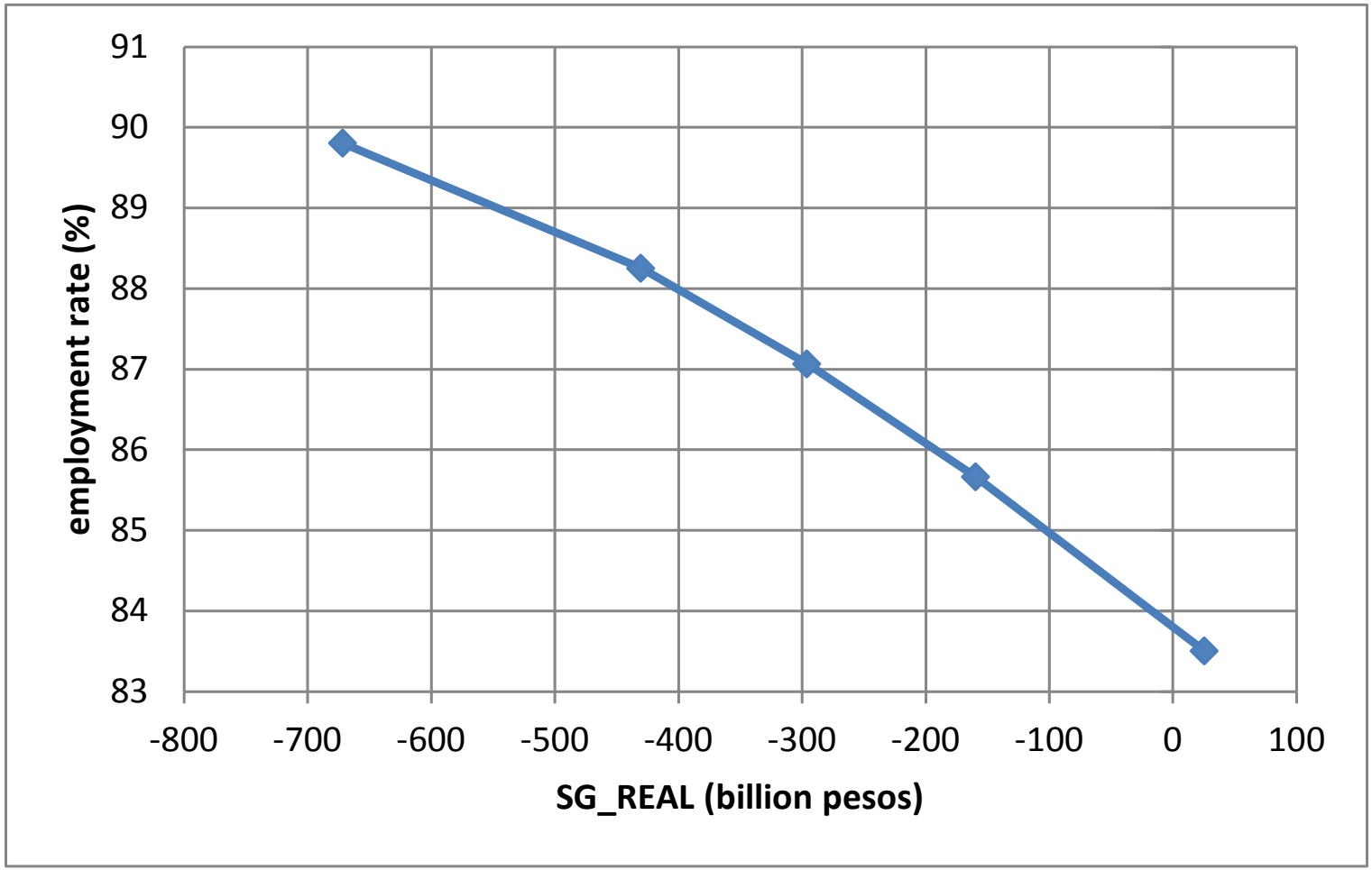
Policy Optimization; minimize unemployment rate

		weights in loss fn		
		UERAT=0	UERAT=0.5	UERAT=1
	base	SG_REAL=1	SG_REAL=0.5	SG_REAL=0
Item	(1)	(2)	(3)	(4)
Private consumption	1,829.3	1,829.3	1,877.7	1,930.1
Private investment	473.5	473.5	218.4	0.0
Government consumption	417.1	417.1	642.7	783.5
Exports	428.1	428.1	386.9	358.0
Imports	379.3	379.3	338.6	309.3
GDP at factor cost	2,371.8	2,371.8	2,411.2	2,407.9
Real governement savings	25.7	25.7	-295.7	-671.1
Current account balance	-11.30	-11.30	-11.30	-11.30
Real exchange rate (index)	1.000	1.000	0.970	0.957
Unemployment rate (%)	16.50	16.50	12.94	10.20
Loss	0.0	0.00	0.20	0.00

Concluding Remarks

- In this paper, we have embedded a computable general equilibrium model within a programming problem for policy simulation
  - policy design is seen as a decision problem with multiple conflicting objectives
- Certainly, we could have selected more than one policy instrument in each simulation
  - for example, taxes could also be optimally selected
  - can restrict the tax rates to vary by less than 5% with respect to their benchmark values

Policy Optimization; trade-off between employment and government savings



Concluding Remarks

- Next, we plan to
  - (a) apply the approach to a relevant policy issue in Argentina and/or elsewhere, and
  - (b) implement dynamic version of the approach, over a recursive dynamic CGE model and assuming that the government is a forward-looking agent.

Additional Slides

Macro SAM Argentina 2012

	act	com	f-lab	f-cap	tax-vat	tax-com	tax-imp	tax-exp	cssoc	tax-dir	hhd	ent	gov	row	sav	invng	invg	dstk	to
act		159.2																	159.2
com	73.4										66.1		15.1	15.5		14.8	2.3	-0.1	187.1
f-lab	47.1													0.0					47.1
f-cap	38.7													0.4					39.1
tax-vat		6.9																	6.9
tax-com		4.5																	4.5
tax-imp		0.6																	0.6
tax-exp		2.2																	2.2
cssoc			6.5																6.5
tax-dir											3.1	5.0							8.1
hhd			40.6									20.8	15.3	0.1					76.8
ent				35.4									0.2	0.1					35.7
gov				1.2	6.9	4.5	0.6	2.2	6.5	8.1	1.3			0.3					31.6
row		13.7	0.0	2.5							0.2	0.3	0.0						16.8
sav											6.1	9.6	0.9	0.4					17.0
invng															14.8				14.8
invg															2.3				2.3
dstk			0.0												-0.1				-0.1
total	159.2	187.1	47.1	39.1	6.9	4.5	0.6	2.2	6.5	8.1	76.8	35.7	31.6	16.8	17.0	14.8	2.3	-0.1	

Factor Intensities

Sector	Labor	Capital	Land	Total
Agriculture, forest and fish	31.6	32.9	35.5	100.0
Other mining	21.1	78.8	0.0	99.9
Petroleum and gas	21.1	78.8	0.0	99.9
Food	45.0	48.4	0.0	93.4
Textiles and apparel	45.0	48.4	0.0	93.4
Petroleum products	45.0	48.4	0.0	93.4
Chemicals, rubber and plast	45.0	48.4	0.0	93.4
Metals, mach and equip	45.0	48.4	0.0	93.4
Vehicles	45.0	48.4	0.0	93.4
Other manufacturing	45.0	48.4	0.0	93.4
Elect, gas and water	26.4	73.6	0.0	100.0
Construction	42.1	45.7	0.0	87.7
Trade	43.2	42.5	0.0	85.7
Transport and comm	56.4	38.4	0.0	94.8
Other services	41.0	53.2	0.0	94.2
Public administration	100.0	0.0	0.0	100.0
Education and health	69.6	26.5	0.0	96.0
Total	48.8	42.7	2.4	93.9