

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## Topics for today's presentation:

- Framework
- Modules
- Data
- Specificities
- Nested production function
- Nested consumption function
- Labour market
- Dynamics
- Miscellaneous treatments
- Closures and experiment
- Challenge ahead

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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

- Framework
  1. We characterized our CGE as a *small-open economy* model designed to answer issues relative to sectoral performance of the economy, given hypothetical or factual shocks.
  2. We aim at providing the best estimations possible to the policy makers about impacts that some public policy would have.
  3. Along with DSGE models, we strive to provide references for macroeconomic performance.

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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## ■ Modules:

- Non-rentistic economy.
- Oil rentistic economy.
- Rentistic economy with non-neutral money.
- Rentistic economy with rationing in markets.
- Rentistic economy with non-neutral money and rational expectations.

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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

- SAM 2005: 23 products and 21 activities.
- 2 production factors: L and K (NR to be added)
  - L splitted into formal and informal and mobile across sectors.
  - K specific.

(Currently working on the possibility of making factors sluggish).
- 4 sectoral institutions: hh, gov., nog and row.
  - hh classiffied in 10 income deciles.



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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

Today, I shall comment about our *non-rentistic* CGE model.

The model in question shows *standard* features of small-open-economy type, with certain variations. To wit:

# UN MODELO DE EQUILIBRIO GENERAL COMPUTADO PARA VENEZUELA

- domestic prices differ according to the demand type (e.g. the value-added tax could be levied on final sales only);
- labour markets reflect endogenous unemployment, so L markets could adjust through  $W$  and  $U$ .;
- tax system is specified in detail;
- the CPI might be endogenously determined;
- closure rules are flexible;
- we introduce quotas for both production and imports.

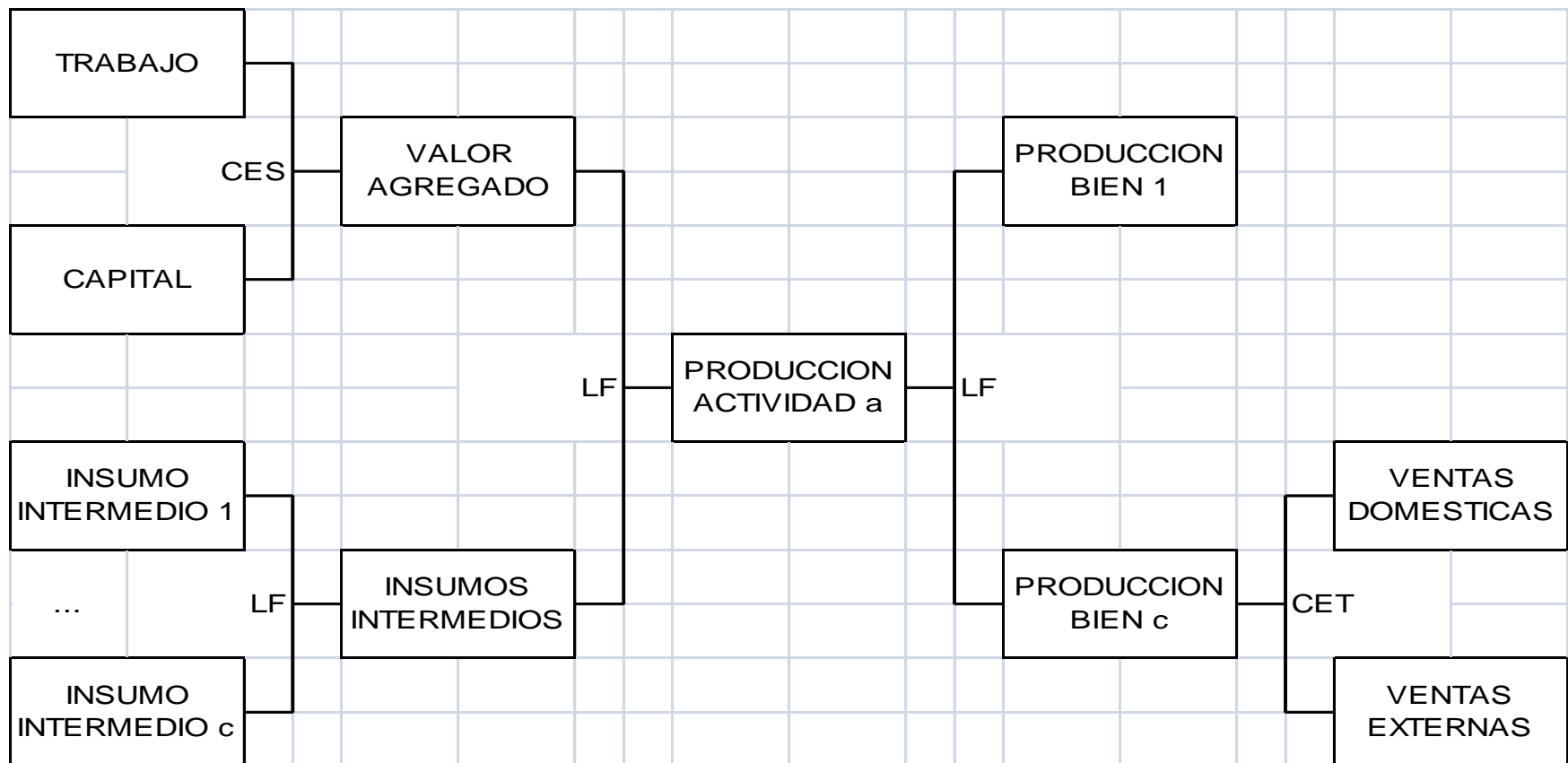
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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

- Nested production function:



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

In which *the producer problem* is typically specified as follow:

$$\begin{aligned} \text{Min}_{QF_{f,a}} \quad & \sum_f W F_f W F D I S T_{f,a} (1 + T F A C T_{f,a}) Q F_{f,a} \\ \text{s. a. } \quad & Q V A_a = \phi_a \left( \sum_f \delta_{f,a}^{va} Q F_{f,a}^{-\rho v a_a} \right)^{-\frac{1}{\rho v a_a}} \end{aligned}$$

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

The first order condition (FOC)

$$QF_{f,a} = \left( \frac{\lambda_a}{WF_f WFDIST_{f,a} (1 + TFACT_{f,a})} \right)^{\sigma_{va_a}} (\delta_{f,a}^{va})^{\sigma_{va_a}} (\phi_a)^{\sigma_{va_a}-1} QVA_a$$

$$QVA_a = \phi_a \left( \sum_f \delta_{f,a}^{va} QF_{f,a}^{-\rho_{va_a}} \right)^{-\frac{1}{\rho_{va_a}}}$$

where the lagrange multiplier takes the VA price,

$$\lambda_a = PVA_a.$$

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## *Parameter calibration of the production function*

By the FOC we calibrate the distribution and scale parameters, respectively.

$$\delta_{f,a}^{va} = \frac{(QF_{f,a})^{\rho va_a} WF_f WFDIST_{f,a} (1 + TFACT_{f,a})}{\sum_{f'} (QF_{f',a})^{\rho va_a} WF_{f'} WFDIST_{f',a} (1 + TFACT_{f',a})}$$

$$\phi_a = \frac{QVA_a}{\left( \sum_f \delta_{f,a}^{va} QF_{f,a}^{-\rho va_a} \right)^{-\frac{1}{\rho va_a}}}$$

Naturally, for the calibration we employ the SAM's values of the endogenous variables.



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

So, how we write the production function in the model?

## LEVEL 1: accounting equilibrium

$$QVA_{a,t} = iva_{a,t}QA_{a,t}$$

$$PA_{a,t} \left( 1 - TA_{a,t} - URNTQAMAX_{a,t} \right) QA_{a,t} = PVA_{a,t}QVA_{a,t} + PINTA_{a,t}QINTA_{a,t} \leftarrow \text{cero profit condition}$$

$$QINTA_{a,t} = inta_a QA_{a,t}$$

$$PINTA_{a,t} = \sum_c PQD_{c,a,t} ica_{ca} \leftarrow \text{where } ica \text{ is the share de i.c of commodity } c \text{ per unit of intermediate input in activity } a.$$

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## LEVEL 2: FOC

$$QVA_{a,t} = \phi_a \left( \sum_f \delta_{f,a}^{va} QF_{f,a,t}^{-\rho va_a} \right)^{-\frac{1}{\rho va_a}} \quad (\text{FP5})$$

$$QF_{f,a,t} = \left( \frac{PVA_{a,t}}{WF_{f,t} WFDIST_{f,a,t} (1 + TFACT_{f,a,t})} \right)^{\sigma va_a} (\delta_{f,a}^{va_a})^{\sigma va_a} (CALTFP_t \phi_a)^{\sigma va_a - 1} QVA_{a,t} ZETA_{f,t} \quad (\text{FP6})$$

$$WF_{fcap,t} WFDIST_{fcap,a,t} (1 + TFACT_{fcap,a,t}) QF_{fcap,a,t} = PVA_{a,t} QVA_{a,t} - \sum_{f \in fncap} (WF_{f,t} WFDIST_{f,a,t} (1 + TFACT_{f,a,t}) QF_{f,a,t}) \quad (\text{FP6'})$$

$$QINT_{c,a,t} = ica_{c,a} QINTA_{a,t} \quad (\text{FP7})$$

Observe that the variable **ZETA** becomes endogenous when the L demand gets exogenous, activating the equation F6', which in turn compute the rental rate of K residually; i.e., employment and wages exogenous are subsidized by K

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## LEVEL 2: PRODUCTION AND IMPORTS QUOTAS

$$qamax_{a,t} \geq QA_{a,t} \quad a \in aqamax$$

$$URNTQAMAX_{a,t} \geq 0 \quad a \in aqamax$$

$$(qamax_{a,t} - QA_{a,t})URNTQAMAX_{a,t} \geq 0 \quad a \in aqamax$$

$$TOTRNTQAMAX_t = \sum_a URNTQAMAX_{a,t} PA_{a,t} QA_{a,t}$$

$$PM_{c,ac,t} = (1 + TM_{c,ac,t} + URNTQAMAX_{c,t}) EXR_t p_{wm_{c,t}}$$

$$PE_{c,r} = (1 - TE_{c,r}) EXR_t PWE_{c,r}$$

We took in consideration that Venezuela might be a big producer (e.g., oil). That's why the variable PWE appears as endogenous (uppercase) for the commodity  $c$  production:  $c \in ced$  (the set  $ced$  that shows what commodities have CET); if  $ced$  is empty, the variable PWE=pwse is exogenous.

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## LEVEL 2: COMPOSED CONSUMPTION GOODS

$$QQ_{c,ac,t} = \phi_{c,ac} \left( \delta q_{c,ac}^M QM_{c,ac,t}^{-\rho_{c,ac}} + \delta q_{c,ac}^D QD_{c,ac,t}^{-\rho_{c,ac}} \right)^{-\frac{1}{\rho_{c,ac}}} \quad (\text{IM1})$$

Imperfect substitution between  $c$  domestic and imported type CES (Armington)

$$QQ_{c,ac,t} = QM_{c,ac,t} + QD_{c,ac,t} \quad (\text{IM1}')$$

IM1' activates  $\times c$  commodities that are demanded either domestically or imported, only.

$$\frac{QM_{c,ac,t}}{QD_{c,ac,t}} = \left( \frac{PD_{c,t}}{PM_{c,ac,t}} \frac{\delta q_{c,ac}^M}{\delta q_{c,ac}^D} \right)^{\frac{1}{1+\rho_{c,ac}}} \quad (\text{IM2})$$

Tangence condition (F.O.C.)

$$PQS_{c,ac,t} QQ_{c,ac,t} = PD_{c,ac,t} QD_{c,ac,t} + PM_{c,ac,t} QM_{c,ac,t} \quad (\text{IM3})$$

Supply price of commodity  $c$

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## NIVEL 2: IMPORT QUOTAS

$$qmmax_{c,t} \geq \sum_{ac} QM_{c,ac,t} \quad c \in cqmax \quad (IM9)$$

$$URNTQMMAX_{c,t} \geq 0 \quad (IM10)$$

$$\left( qmmax_{c,t} - \sum_{ac} QM_{c,ac,t} \right) URNTQMMAX_{c,t} = 0 \quad (IM11)$$

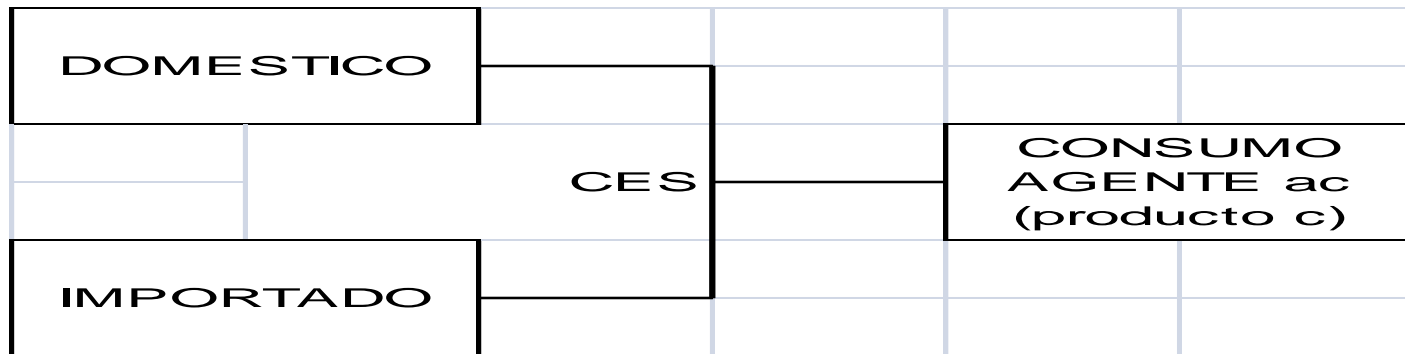
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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

- Nested consumption function:



The representative consumer is modeled by a *Stone-Geary* utility function (*ELES*).

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

*The consumer problem:*

$$\underset{QH_{c,h}}{\text{Max}} \prod_c (QH_{c,h} - \gamma_{c,h})^{\beta_{c,h}}$$

s.a.

$$EH_h = \sum_c PQD_{c,h} QH_{c,h}$$

Where  $QH$  is the good  $c$  consumption good in household  $h$ ,  $\gamma$  is survival consumption and  $\beta$  accounts for the share of  $c$  in the household  $h$  consumption;  $PQD$  is the demand price of composed goods and  $EH$  is the consumption expenditure of household  $h$ .



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## FOC

$$QH_{c,h} = \gamma_{c,h} + \frac{\beta_{c,h}}{PQD_{c,h}} \left( EH_h - \sum_{c'} PQD_{c',h} \gamma_{c'h} \right)$$

## CALIBRATION

To calibrate the value of the distribution parameter  $\beta_{c,h}$ , it's necessary estimating income demand elasticity for the commodity  $c$  in the household  $h$  ( $leselas(c,h)$  in the model). The income demand elasticity is defined as

$$\varepsilon_{c,h}^{EH} = \frac{dQH_{c,h}}{dEH_h} \frac{EH_h}{QH_{c,h}}$$

$$\varepsilon_{c,h}^{EH} = \frac{\beta_{c,h}}{PQD_{c,h}} \frac{EH_h}{QH_{c,h}}$$

$$\beta_{c,h} = \varepsilon_{c,h}^{EH} \frac{PQD_{c,h} QH_{c,h}}{EH_h}$$

The Engels' aggregation could be written as

$$\frac{\sum_c PQD_{c,h} QH_{c,h} \varepsilon_{c,h}^{EH}}{EH_h} = 1 \quad \text{and it is employed to "adjust" the income elasticity.}$$

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## CALIBRATION

To calibrate the parameter  $\gamma_{c,h}$ , we should know the value of the Frisch's parameter (i.e., total consumption / discretionary consumption).

$$frisch_h = -\frac{EH_h}{EH_h - \sum_c PQD_{c,h}\gamma_{c,h}}$$

So,  $\gamma_{c,h}$  is

$$\gamma_{c,h} = QH_{c,h} + \frac{\beta_{c,h}}{PQD_{c,h}} \left( \frac{EH_h}{frisch_h} \right)$$

In the dynamic version of the model, the value of  $\gamma_{c,h}$  is updated to reflect the population growth.

The values -1 (for the Frisch parameter) and 1 (for the income elasticity) transform a Stone-Geary into a Cobb-Douglas utility function;

The Frisch parameter estimation is usually made considering the relation  $frisch = -36 * ypc^{**}$  (-0.36), —Lluch et al (1973).—where  $ypc$  es the income *per capita*.

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

In the model, households' demand are written as

$$EH_{h,t} = \left( 1 - \sum_i shii_{i,t} \right) \left[ (1 - TY_{h,t}) YI_{h,t} - INSSAV_{h,t} \right]$$

$$PQD_{c,h,t} QH_{c,h,t} = PQD_{c,h,t} \gamma_{c,h,t} + \beta_{c,h} \left( EH_{h,t} - \sum_{c'} PQD_{c',h,t} \gamma_{c',h,t} \right)$$

The latter is the FOC.

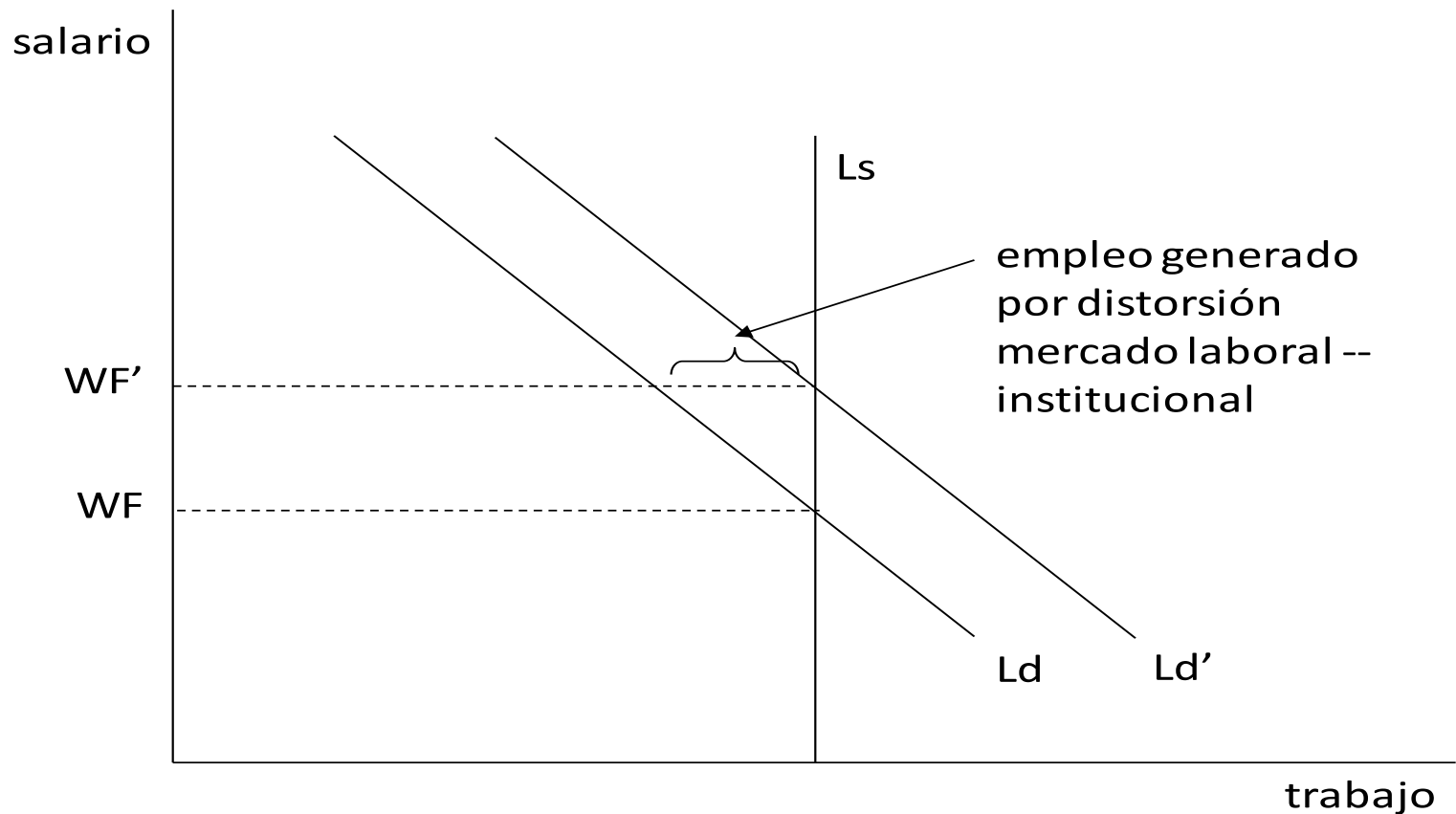
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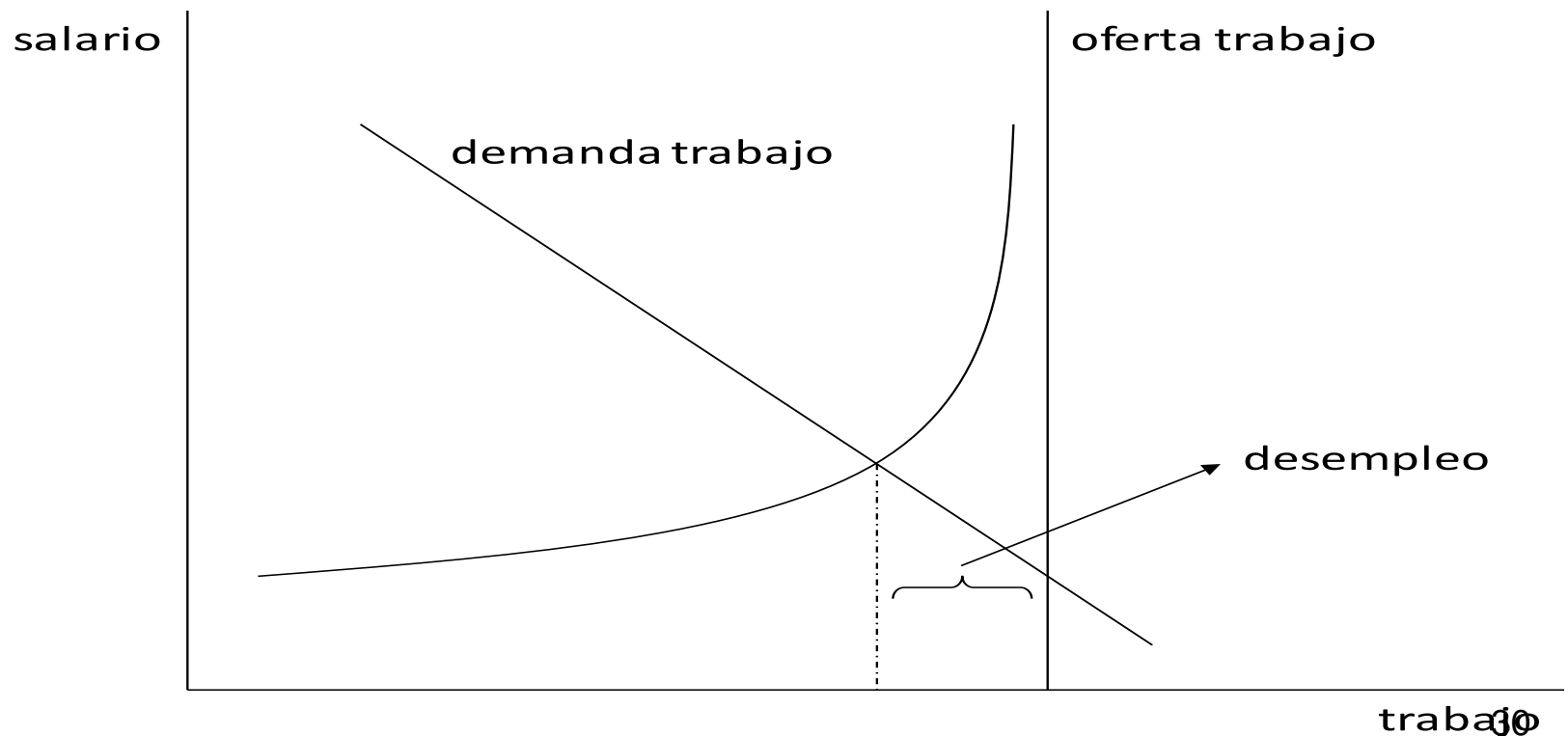
# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

- Labour market: unemployment caused by exogenous nominal minimum wage.



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

- Labour market: wage curve (with exogenous minimum wage).



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## UNEMPLOYMENT

$$WFREAL_{f,t} = \frac{WF_{f,t}}{CPI_t}$$

$$\frac{WFREAL_{f,t}}{WFREAL00_f} - 1 = -\text{phillips}_f \left( \frac{UERAT_{f,t}}{UERAT00_f} - 1 \right)$$

$$WFREALMIN_{f,t} = \overline{wfrealmin}_{f,t}$$

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## UNEMPLOYMENT

$$WFREAL_{f,t} \geq WFREALMIN_{f,t} \quad f \in fuendog \quad (U4)$$

$$UERAT_{f,t} \geq ueratmin_{f,t} \quad f \in fuendog \quad (U5)$$

$$(WFREAL_{f,t} - WFREALMIN_{f,t}) (UERAT_{f,t} - ueratmin_{f,t}) = 0 \quad (U6)$$

(U6) reflects a complementarity condition between real wages and unemployment rate that allows modelling two situations: i) real wage is equal to the minimum real wage and there exists unemployment, or ii) the real wage is higher than the minimum real wage and there no exists unemployment.



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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## DYNAMICS

$$WFAVG_{f,t} = \frac{\sum QF_{f,a,t} WF_{f,t} WFDIST_{f,a,t} (1 + TFACT_{f,a,t})}{\sum_{a'} QF_{f,a't}} \quad (D1)$$

Investment in each period contributes to increase the capital stock in next periods. Hence, at the end of each period, investment is distributed among sectors.

(D1) computes the average return of each factor.

$$SHCAPNEW_{fcap,a,t} = \frac{QF_{fcap,a,t}}{\sum_{a'} QF_{fcap,a't}} \left[ 1 + \kappa \left( \frac{WF_{fcap,t} WFDIST_{fcap,a,t} (1 + TFACT_{fcap,a,t})}{WFAVG_{fcap,t}} - 1 \right) \right] \quad (D2)$$

The activity weight in the new capital stock is reckoned in (D2). The  $k$  parameter—varies between zero and one—measures the capital mobility among sectors. When  $k$  is zero, investment is allocated following the initial (benchmark) participation (i.e., SAM). When  $k$  is positive, investment allocation is done by considering different rental rate of capital.

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## DYNAMICS

Prices of private and public capital goods by (D3) y (D4), respectively.

$$PCAP_{fcap,t} = \sum_{c,inv} iccap_c PQD_{c,inv,t} \quad (D3)$$

$$PCAPG_{fcap,t} = \sum_{c,inv} iccap_g PQD_{c,inv,t} \quad (D4)$$

The new capital that each sector receives at the end o each period  $t$  is estimated in the equation (D5).

$$QCAPNEW_{fcap,a,t} = SHCAPNEW_{fcap,a,t} \frac{\sum_{c,inv} PQD_{c,inv,t} QINV_{c,t}}{PCAP_{fcap,t}} + SHCAPNEW_{fcap,a,t} \frac{\sum_{c,inv} PQD_{c,inv,t} QINVG_{c,t}}{PCAPG_{fcap,t}} \quad (D5)$$

$$QF_{fcap,a,t} = (1 - deprcap_{fcap}) QF_{fcap,a,t-1} + QCAPNEW_{fcap,a,t-1} \quad (D6)$$

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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## MISCELLANEOUS

$$REXR_t = \frac{EXR_t}{DPI_t} \quad (\text{MIS1})$$

$$fsavmax_t \geq FSAV_t \quad (\text{MIS2})$$

$$REXR_t \geq REXR0_t \quad (\text{MIS3})$$

$$(fsavmax_t - FSAV_t)(REXR_t - REXR0_t) = 0 \quad (\text{MIS4})$$

(MIS2)-(MIS4) might be employed to impose a mixed rule to ROW's current account. We assume that ROW might finance the domestic economy within certain limits. When a predetermined limit is reached, the exchange rate becomes endogenous to balance the current account.

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## MISCELLANEOUS

$$MONEY_t = \sum_{c,ac} PQD_{c,ac,t} QQ_{c,ac,t} \quad (MIS5)$$

The (MIS5) equation is the “*cash in advance*” condition (Clower, 1967) that might be used to determine the CPI by exogenizing the amount of *MONEY*. Thus, we might be able to study the impacts of exogenous changes in the CPI. This is, we endogenized *CPI* and exogenized *MONEY*.

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# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## CLOSURES

**FACTOR MARKETS:** mobile or specific. Sluggish factor to be developed

**GOVERNMENT:** three alternatives with constant tax rates.

- i. Real public outlays exogenous whereas government savings are endogenous,
- ii. Real public expenditure endogenous and government savings exogenous,
- iii. Both the public expenditure and savings endogenous but government expenditure is constant in the absorption

In addition, a tax rate could be endogenized to keep public consumption and government savings constant.

**ROW:** Two alternatives

- i. ROW savings fixed REXR endogenous
- ii. ROW savings flexible REXR exogenous

**PRIVATE SAVINGS AND INVESTMENTS:** three alternatives.

- i.* Inv. exogenous-MPS endogenous (*investment driven*)
- ii.* Inv. endogenous -MPS exogenous (*saving driven*)
- iii. Inv. as a fixed proportion of the absorption whereas Inv y MPS get flexible.



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## EXPERIMENT:

- 1.Oil increase in 45%
- 2.RXR depreciation in 2.3%
- 3.Real public expenditure increase in 29%
- 4.Real transfer gov-hhd increase in 24%
- 5.Public investment increase in the construction sector in 30%

## Closures:

- 1.RowClos0= REXR flexible for all with the exception of 2.
- 2.GovClos0= 1, GSAV flexible-GADJ fixed -Taxes and GInv.also fixed;
- 3.S-IClos0= 1, IADJ fixed, MPSADJ flexible

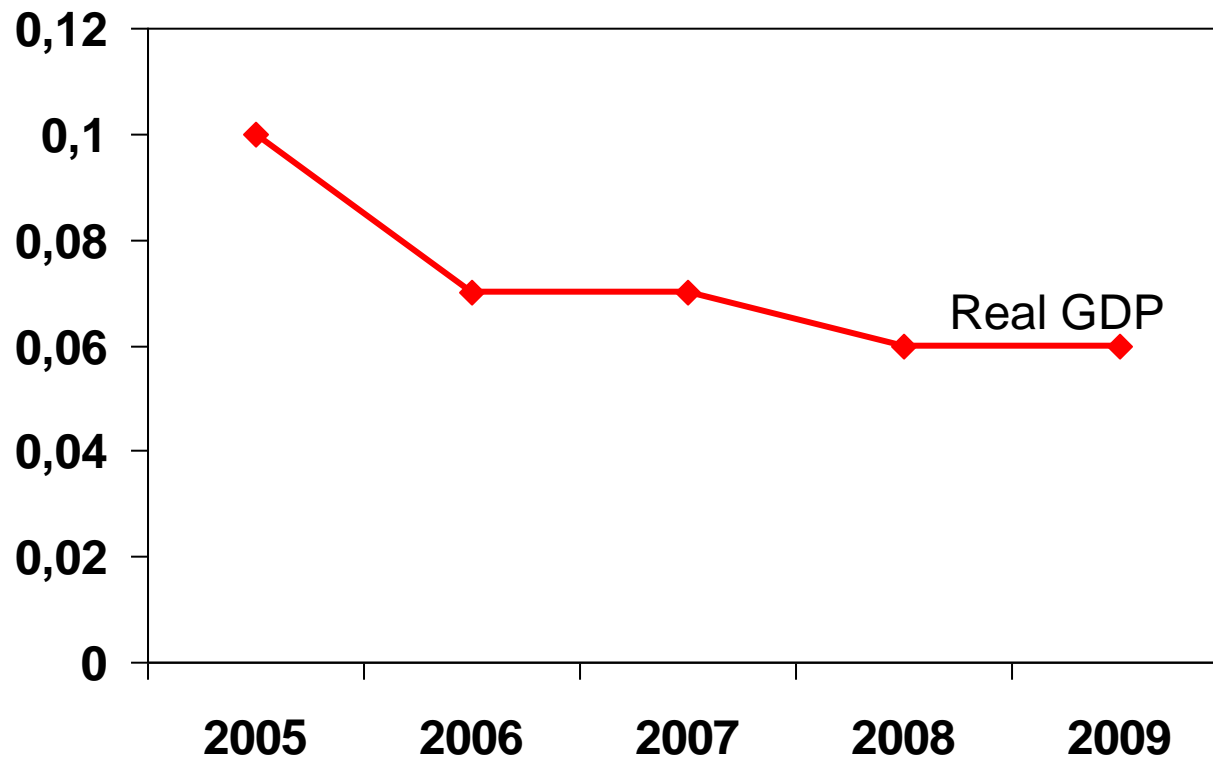
# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## Data assumptions:

1. Elasticity of substitution CES VA is 1.05
2. Income-demand elasticity equal to 1
3. We assigned -1 for the Frisch parameter
4. CET equal to 4
5. Armingtons range between 1.9 and 8.3  
(we are working on estimating these elasticities econometrically)
6. Initial unemployment rate of 10%
7. Minimum unemployment rate for classic endogenous unemployment of 2.5%
8. Wage unemployment elasticity of -0.13.

## SIMULATIONS' IMPACT OVER MACROECONOMIC AGGREGATES

Real GDP % deviation with respect  
basecase forecast



# SIMULATIONS' IMPACT OVER MACROECONOMIC AGGREGATES

**Output precentage variation w.r.t. the basecase forecast  
(considering all shock combinations)**

Year	a-comer	a-const	a-extracpetrol	a-maquin	a-otrmanuf	a-otrservic	a-refpet	a-vehic
2005	-0,18	2,93	0,03	-0,33	-0,17	-0,17	0,29	-0,25
2006	0,07	0,01	0,10	0,03	0,08	0,08	0,07	0,07
2007	0,07	0,01	0,09	0,03	0,07	0,07	0,07	0,06
2008	0,06	0,01	0,09	0,03	0,07	0,07	0,06	0,06
2009	0,06	0,01	0,08	0,02	0,06	0,06	0,06	0,05

## SIMULATIONS' IMPACT OVER MACROECONOMIC AGGREGATES

**Real GDP Percentage change with respect to the basecase forecast**

(Per simulation)

Year	govcon-1	pwe-rowclos1	qinvg-1	rxr-2	trnsfr-1
2005	0,664	1,867	0,097	0,189	0,073
2006	-0,016	-0,120	0,074	-0,015	-0,006
2007	-0,014	-0,112	0,069	-0,014	-0,005
2008	-0,013	-0,105	0,064	-0,013	-0,005
2009	-0,013	-0,098	0,060	-0,012	-0,005

## SIMULATIONS' IMPACT OVER MACROECONOMIC AGGREGATES

### Welfare impact in the three lowest income deciles (per simulation)

Billions of Bs

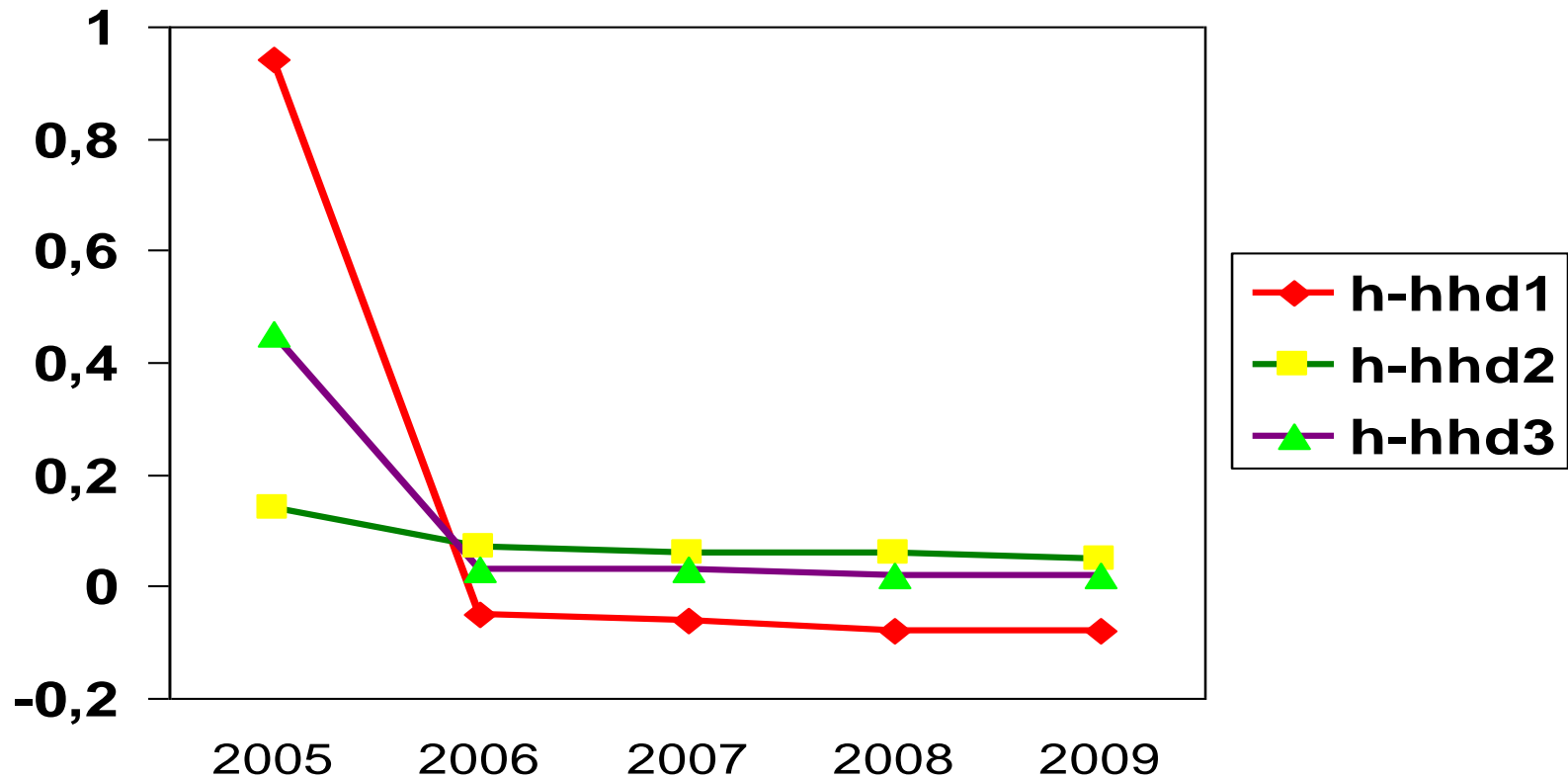
Simulation	h-hhd1*	h-hhd2*	h-hhd3*
govcon-1	1,327	0,334	1,611
pwe-rowclos1	-5,125	4,918	1,289
qinvg-1	0,248	0,056	0,253
rxr-1	-1,649	0,569	-0,663
trnsfr-2	1,714	1,043	1,960

\* The lowest income deciles account for 30% of total population and earn 9% of total annual income per capita

# SIMULATIONS' IMPACT OVER MACROECONOMIC AGGREGATES

Households expenditure variation w.r.t.  
basecase forecast

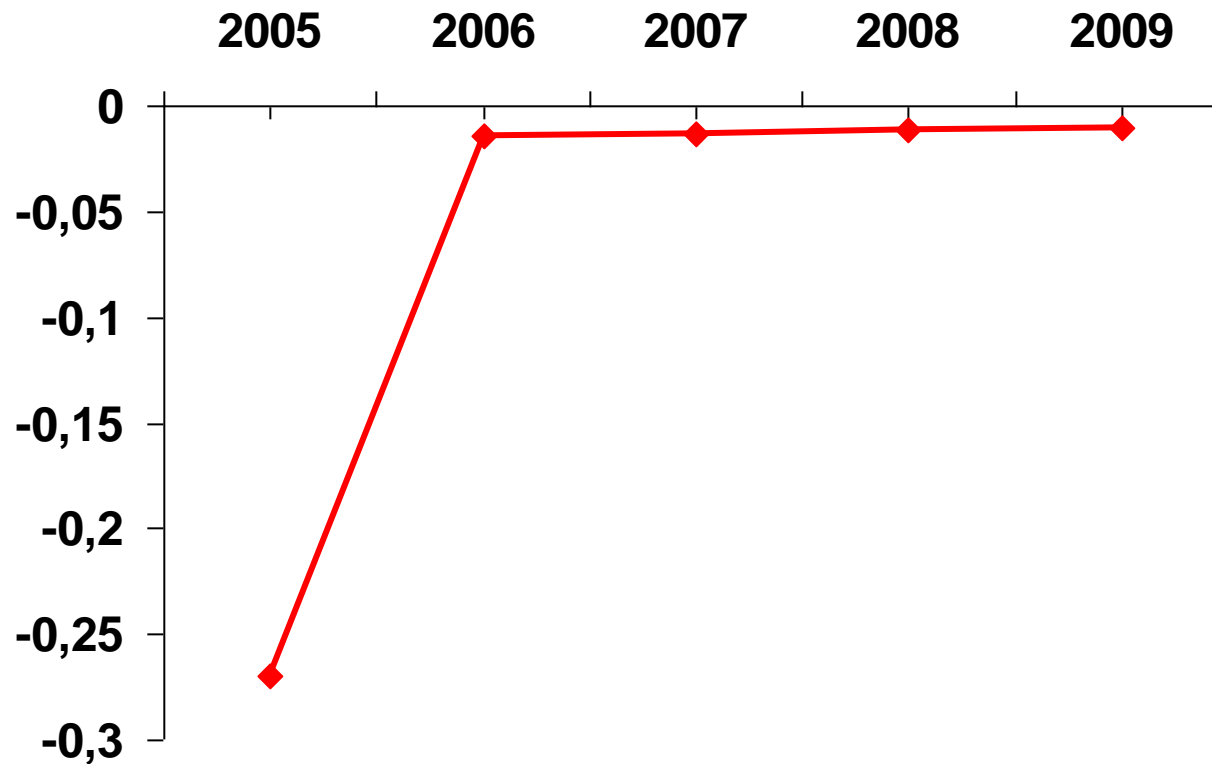
(the three lowets income deciles)



## SIMULATIONS' IMPACT OVER MACROECONOMIC AGGREGATES

Real exchange rate behavior w.r.t.  
basecase forecast

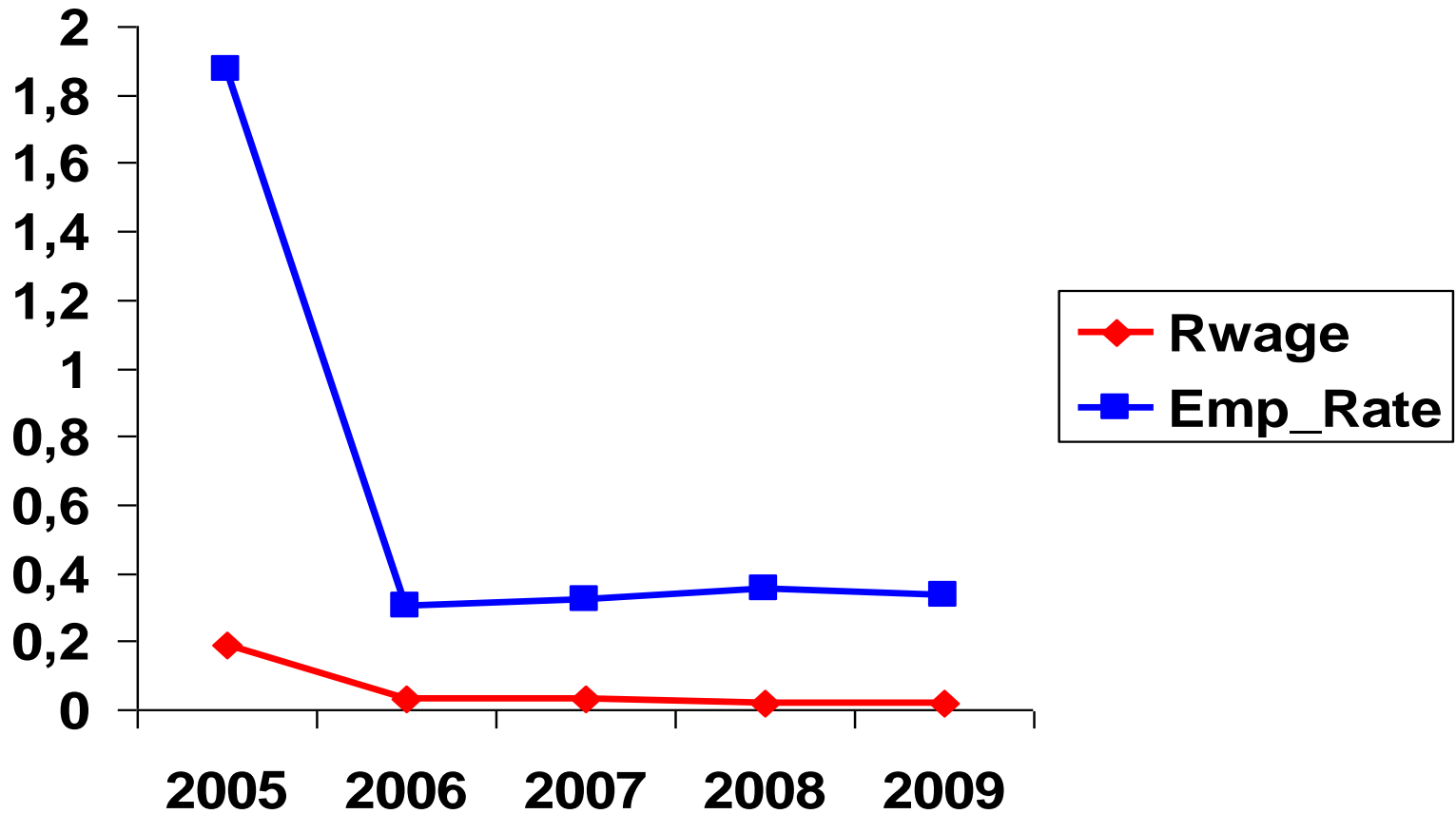
(positive variation means depreciation)





# SIMULATIONS' IMPACTS OVER EMPLOYMENT AND REAL WAGES

(evolution w.r.t. base case forecast)



# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

Topics for today's presentation:

- Framework
- Modules
- Data
- Specificities
- Nested production function
- Nested consumption function
- Labour market
- Dynamics
- Miscellaneous treatments
- Closures and experiment
- **Challenges ahead**

# A STATIC-DYNAMIC CGE MODEL FOR VENEZUELA

## DATA:

1. Econometric estimation of parameters in an economy in transition
2. Investment-Savings treatment:
  - a. Dispositions (negative investments)
  - b. Investment by activities rather than by institutional sectors
  - c. Negative savings in households

## MODELLING:

1. *Cash-in-advance* treatment doesn't yield the expected results: Increase in nominal wages are not reflected in CPI increase.
2. What's ideal size of this type of model? The model tends to grow in size to answer complex questions: e.g. effects of nominal variables changes in real ones.