FONDAZIONE ENI ENRICO MATTEI

Energy, welfare and inequality: a micro-macro reconciliation approach for Indonesia

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Outline

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Motivation

- The General Equilibrium models
  - captures direct and indirect effects of a policy
  - focuses on aggregate efficiency, not considering distributional impacts
- Microsimulation models are
  - partial equilibrium analyses
  - deal with inequality
- A macro-micro simulation approach allows evaluating the effect of a policy in terms of efficiency, welfare change and equity

- Requirements: CGE model, household survey, microsimulation model

Micro-macro linkage

- Representative Household approach (Dervis, 1982, Decaluwé, 1999)
- Integrated Multi-household approach (Rutherford et al., 2006; Boccanfuso et al., 2003)
- Top-Down Microsimulation models
  - No-behavioural response (Chen and Ravallion, 2004; Dartanto, 2013)
  - Behavioural response (Bourguignon et al., 2003; Hérault, 2010)
- Closed-loop Top-Down (Savard, 2005)

Top-down approach with no-behavioural response

- Price changes simulated with the CGE do not give way to behavioral adjustments from the households: the price shocks directly translate into expenditures and incomes variations
- This approach allows dealing with a high number of heterogeneous household; including them in a multi-country CGE would imply numerical solution problems
- A behavioral soft link would require instead high quality data and a calibration process of all behavioral parameters
- The Top-Down approach can give some insights on the welfare change after a policy implementation
- This exercise evaluate the welfare impact of a fossil fuel subsidy reduction in Indonesia

Welfare change assessment

- The welfare change due to a policy implementation can be assessed using the indirect utility function

$$v_i\left(p_j, p_s, m_i\right) = \max\left[u_i\left(c_{ij}, S_i\right) \middle| \sum_j p_{i,j}\, c_{i,j} + S_i = m_i\right]$$

where income is:

$$\sum_k x_{i,k}\left(1 + tax_k^{fct}\right) w_k + \ tr_i = m_i$$

- Using the envelope theorem on the indirect utility function, a first-order approximation of welfare around the optimum is (Chen&Ravallion, 2004)

$$\frac{du_i}{\left(\frac{du_i}{dm_i}\right)} = \left[\sum_k x_{i,k}\left(1 + tax_k^{fct}\right) w_k \frac{dw_k}{w_k} + dtr_i\ \right] - \sum_j p_{i,j}\, c_{i,j} \frac{dp_{i,j}}{p_{i,j}}$$

- The Gini index is used to evaluate the dispersion of some covariates of the welfare change

Indonesia background

- Indonesia is a fast emerging country with a 6% average annual growth rate of GDP driven by demand expansion and a growth of the manufacturing sector, with limited inflation pressures (OECD, 2012)

- Reasons in favour of a fossil fuel subsidy phase out (Ellis, 2010; Dartanto, 2013)
  - Pressure on public budget
  - Need of substantial governments spending in other directions
  - Subsidies induce wasteful consumptions
  - Fossil fuel subsidies fail to fulfil their redistribution role

- Concerns: inequality and access to modern energy

- After several attempts to reduce subsidies and link domestic and international energy fuel prices, in 2013, a revision of Indonesian Budget introduced a cut of fossil fuel subsidies: diesel and gasoline price respectively of 22% and 44%.

Indonesian household survey

- The Indonesia Family Life Survey 4 (IFLS4) is the fourth wave of a households longitudinal panel started in 1993 (RAND Corporation & World Bank)

- IFLS4 surveyed 13,995 households on cultural, social and economic matters from November 2007 to May 2008

- The sample scheme is stratified on rural/urban areas in 14 of the 27 Indonesian provinces and randomly sampled within strata (14 rural and 13 urban); it is representative for 83% of the Indonesian population

Indonesian Household survey (2)

- The IFLS4 sample weights are post-stratification weights that correct for the over-sampling in urban areas of the IFLS1 and are adjusted taking into account the sample attrition from 1993 to 2007

- In order to produce statistics on the populations, the proportional sample weights are converted using the total population in 2007, its distribution across provinces and the average household size (SUSENAS, 2007)

- The new sample weights were rescaled to correct for observations dropped due to missing data in expenditure and income components

Household survey aggregates

- The **expenditure** module collects information on food, non-food goods and services at weekly base, household items monthly and durable goods bought in the analysed year
- The **income** module is obtained merging labour market section (for employed and self-employed individuals) and profits of farm and non-farm businesses
- The **transfer** aggregate includes monetary flows from government and non-profit institutions in the form of conditional and non-conditional support programs
- The survey offers some information on actual **housing rents** and estimated ones for self-owned or occupied dwellings; missing data (6%) were imputed using the predicted mean matching imputation method (PMM)

Household survey and Social Accounting Matrix

- Social Accounting Matrix (SAM) is a static picture of all the economic flows that take place within an economy in a specific year

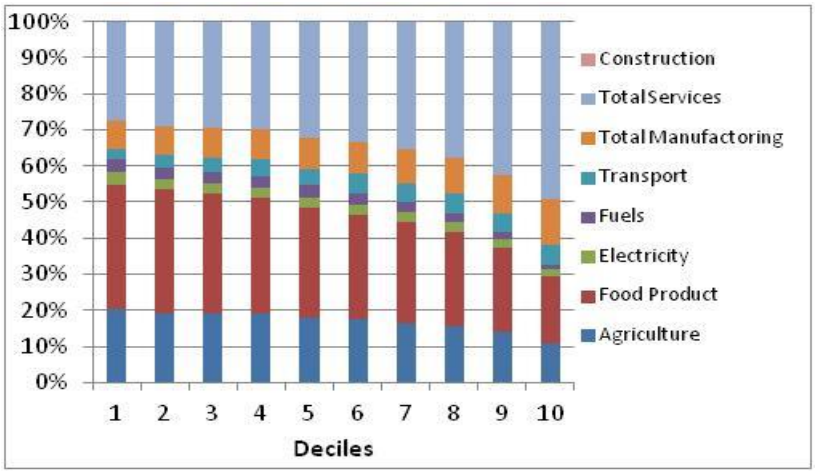
- Homogenizing the macro representation of the economy with the household survey requires to overcome some inconsistencies:
  - Differences in accounting relations
  - Sectoral classification
  - Economic assumptions on primary factors
  - Measurement errors

Household account

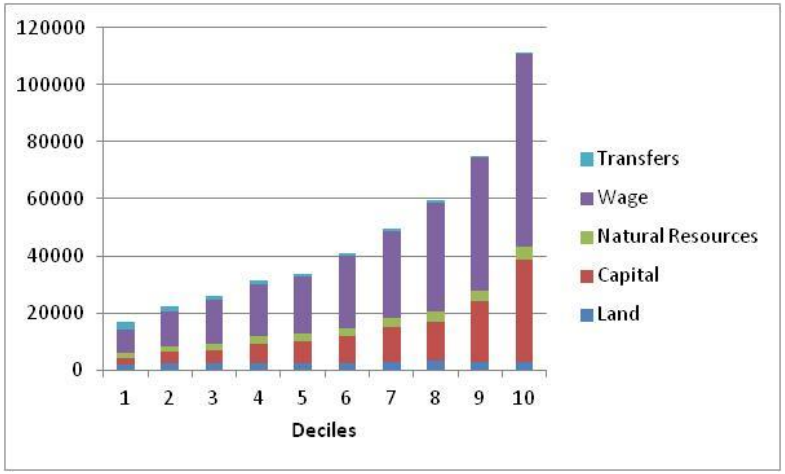
Income	**Outlays**
Wage	Food expenditure
+ Farm business	+ Non-food expenditure
+ Non-farm business	+ Housing expenditure
+ Rent	= **Total expenditure**
+ Other income	+ **Savings**
= **Total income**	= **Total outlays**

Survey results

Households' expenditure in 2007 (IFLS4 results)



Households' income in 2007 (IFLS4 results)



- The expenditure profile across household types shows a decreasing food budget coefficient
- Measurement errors on the income side (expenditure is used as reference of income distribution)
- Expenditure shares per decile are consistent with literature, Gini index is 39 (37 and 38 in 2007 according to WB (2011) and Miranti et al.(2013); 34 according to POVCALNet)
- Profits and wages of farm and no-farm activities are mapped into returns of labour, capital, land and natural resources (Ivanic, 2004)

Reconciliation

- Remaining inconsistences are reconciled with the Cross-Entropy method (McDougall, 1999)
- Reconciled income, expenditure and balanced relations
- Assumption of a unique price

The CGE baseline

$$\sum_k \overline{X_k}\left(1+\tau_k^{fct}\right)\overline{W_k}+\overline{tr}=\bar{M}$$

$$\sum_j \bar{P}_j\left(1+\tau_j^{cons}\right)\bar{C}_j+\bar{S}=\bar{M}\left(1+\tau_j^{inc}\right)$$

Household-level data

$$\sum_k \overline{x_{i,k}}\left(1+\tau_k^{fct}\right)\overline{w_k}+\overline{tr_i}=\overline{m_i}$$

$$\sum_j \bar{P}_j\left(1+\tau_j^{cons}\right)\overline{c_{i,j}}+\bar{s}_i=\overline{m_i}\left(1+\tau_j^{inc}\right)$$

$$\sum_i \bar{c}_{i,j}=\bar{C}_j \qquad \sum_i \bar{x}_{i,k}=\bar{X}_k \qquad \sum_i \bar{m}_i=\bar{M}$$

- The reconciled matrices considering 10018 households are now ready to receive the shocks produced in the CGE model

ENV-Linkages model

- ENV-Linkages a multi-sectoral and multi-regional model Computable General Equilibrium (CGE) describing world economy
- ENV-Linkages relies on national Social Accounting Matrices (GTAP database)
- ENV-Linkages produces future projection up to 2050 through a recursive dynamic process
- In this work a static version of the model for the year 2013 was used
- The baseline calibration fallows the Environmental Outlook to 2050 (OECD, 2012)

ENV-Linkages model

- Firms minimise production costs in perfectly competitive markets, under constant return to scale assumption. Production functions have nested CES formulations
- The representative household utility maximisation gives way to an Extended Linear Expenditure System (Stone–Geary utility function)
- The government generates public expenditure (exogenous), collects taxes (depending on income)
- Government transfers adjust to respect an exogenous trend of deficits
- Other closures: the current account surplus remain constant through exogenous capital outflows and a change in terms of trade

Baseline and policy scenarios

- **Baseline scenario:** the climate policy assumptions correspond to the government policies and measures adopted in the base year and decreasing energy subsidies, except in the case of Indonesia where fossil fuel subsidies are assumed to remain constant

- The Indonesian subsidies to household and firm consumption of energy commodities are calibrated in the base year using IEA's price-gap approach

- "**Transfers**" scenario the decrease of fossil fuel subsidies finances unconditional lump-sum transfers to the households

- "**Government expenditures**" scenario is does not consider the subsidy recycling in transfers to the households. The decrease of fossil fuel subsidy expenditures is used to increase government consumption

Scenarios	Subsidy rate	Transfers to households	Government consumption
Baseline	Exogenous	Endogenous	Exogenous
Transfers	Fixed (-1% w.r.t baseline)	Endogenous	Exogenous
Government expenditures	Fixed (-1% w.r.t baseline)	Exogenous	Endogenous

Aggregate results

- The "Transfer" scenario determines the highest improvement of average household welfare. The negative impact on expenditure is mitigated by the lump sum transfer

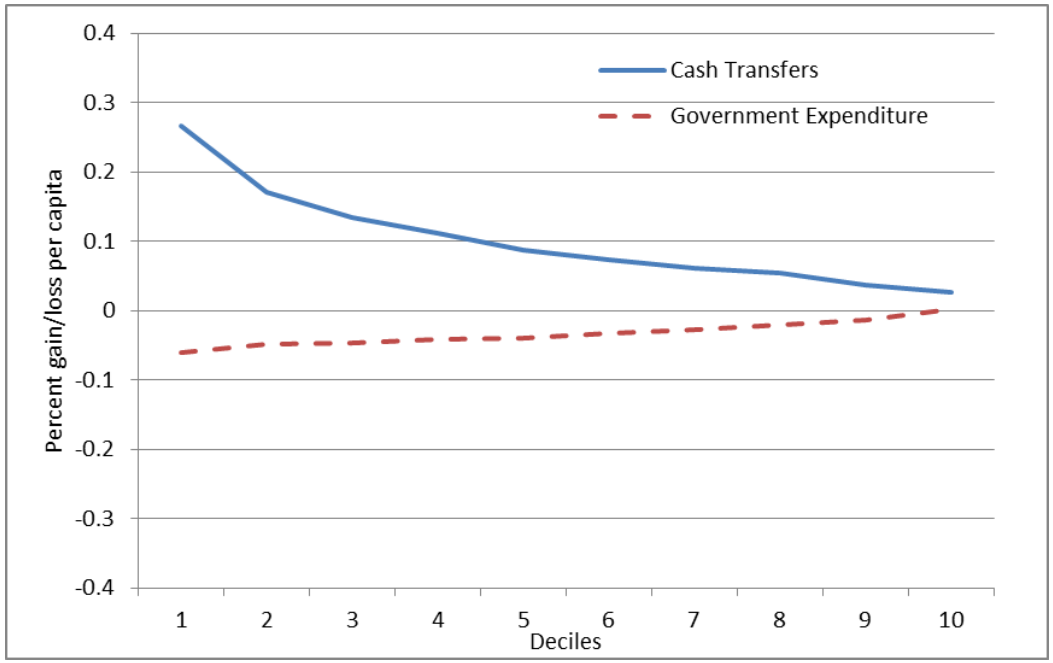
- The "Government Expenditure" scenario is characterised by a loss of welfare that has to be cautiously judged given that the return on government's consumption is not accounted here

(Million USD)	Cash transfers	Government expenditures
Total Income related effects	77	116
Labour	*86*	*82*
Capital	*5*	*60*
Land	*2*	*0*
Natural resource	*-11*	*-16*
Depreciation	*-6*	*-9*
Total expenditure related effects	-162	-175
Elec. subsidy phase out	*-34*	*-34*
Elec. Producer price change	*0*	*0*
Fossil fuel subsidy phase out	*-92*	*-92*
Fossil fuel producer price change	*2*	*2*
Other commodity price changes	*-38*	*-50*
Transfers	266	2
Total	180	-57

Aggregate results (2)

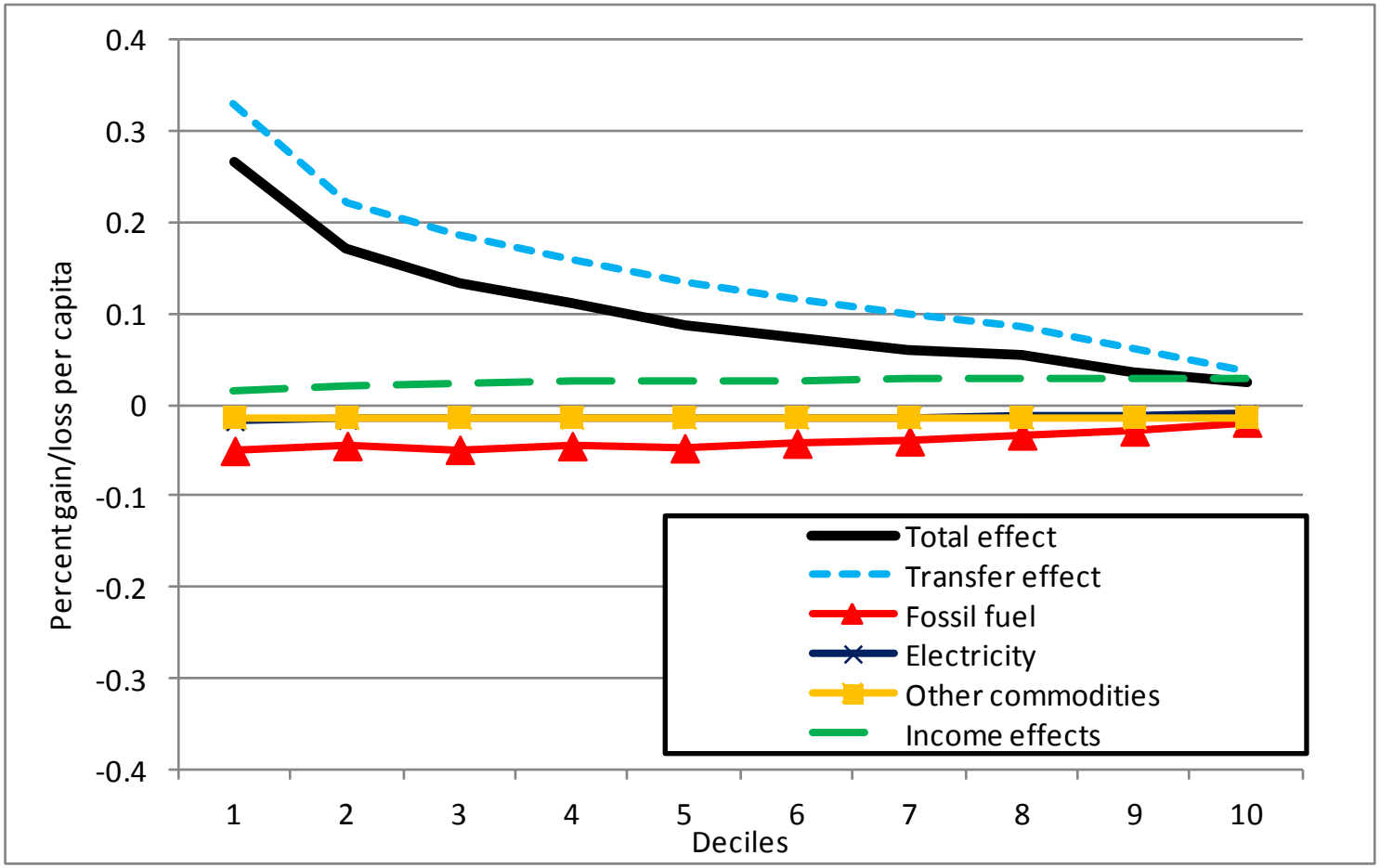
- Labour remuneration rises due to the reallocation of labour toward less energy intensive sectors (Services, Manufacturing and Agriculture)
- Capital remuneration is unchanged in the “cash transfers scenario” and increases in the “government expenditure” scenario due to a crowding-out effect
- The fossil fuel subsidy reduction determines a small decrease of total emissions: -0.18 % in the “cash transfer” scenario and -0.2 % in the “government expenditure”
- Emission from household consumption of fossil fuels shrink of 0.98% in the “cash transfer” scenario and 1.02% in the “government expenditure” scenario.

Welfare gain at decile level

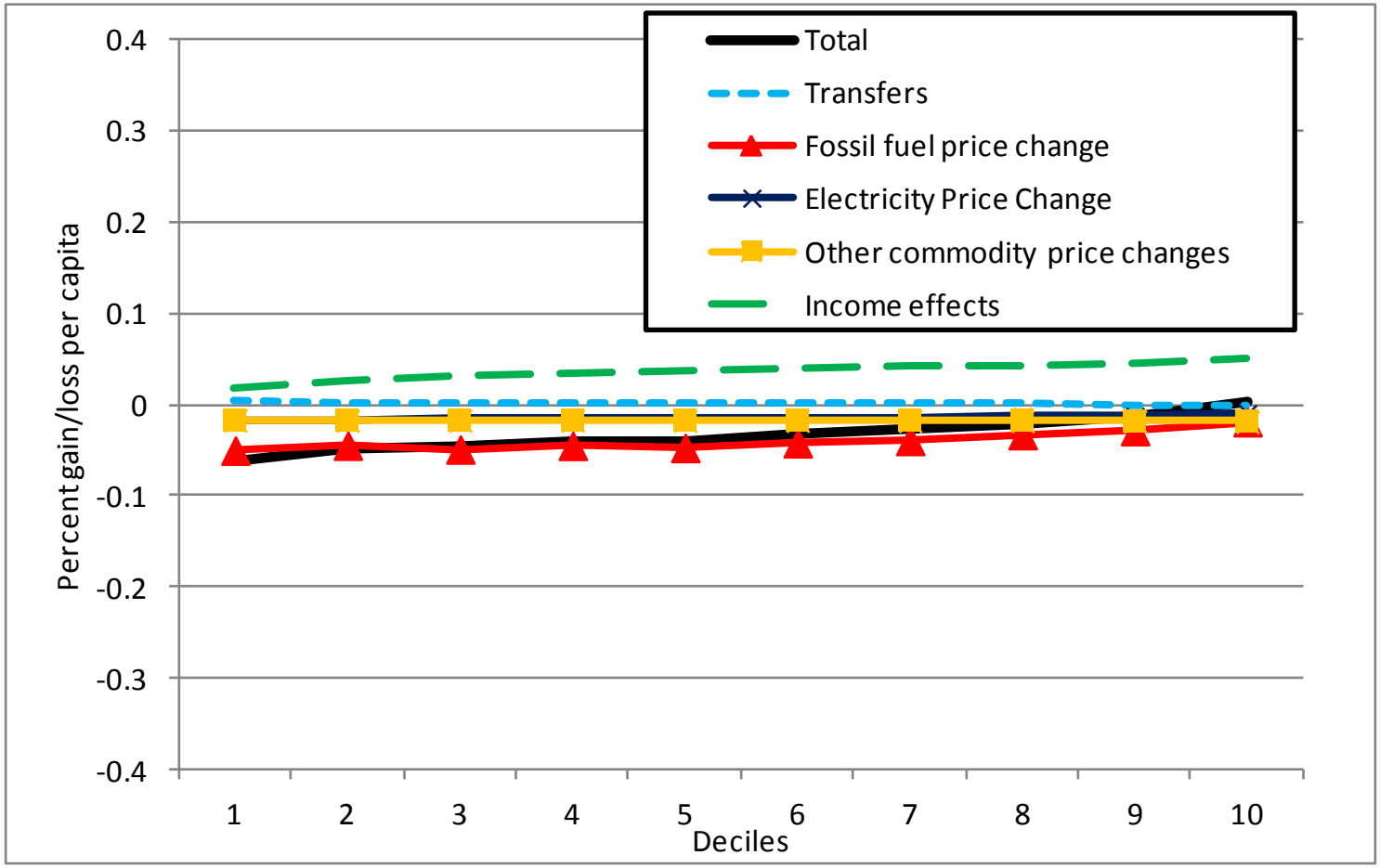


- The "Cash Transfer" scenario is progressive and tends to have a positive impact on all households
- The "Government Spending" scenario is regressive
- The Gini index increases of 0.05% in the "cash transfers" scenario and decreases of 0.01% in the "government expenditure" scenario

Decomposition welfare change, “Cash transfers” scenario



Decomposition welfare change, “Government expenditure” scenario



Conclusions

- Integrating a microsimulation and a macro-economic model offers significant potential for improving the economic analysis of a reform involving both macro and micro sides of the economy
- The literature on the topic is quite wide, mainly focused on trade liberalisation reforms, but can be adapted to assess the effects of different policy interventions
- In the exercise just presented is easy to derivate the welfare change and the distributional implications of a fossil fuel reduction: the progressivity of a fossil fuel subsidy reduction with unconditional transfers
- Even a simple Top-Down microsimulation model without behavioural response is able to shed some light on the underlying response of different population strata to a macroeconomic shock
- This Top-Down microsimulation can be improved accounting for behavioural responses of the agents, iterative feedbacks with the macro model, but also exploiting the wide household survey information (demographic characteristics, location, education level...)

Thank you for your attention

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