Fiscal Policy and inequality in economies with large, unproductive, agricultural sectors*

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February 14, 2012

Abstract

Poor countries devote the largest fraction of their labor force to agriculture, which is also their least productive sector. This turns out to be key for understanding cross-country disparities in per capita incomes. A large and active literature aims at finding the causes behind these facts. Most models employed highlight that a minimum (subsistence) level of agricultural production is required before the economy can produce anything else. Hence, "too many" resources may be devoted to an unproductive sector. We evaluate the interactions between fiscal policy (in particular infrastructure investment), income inequality, and economic performance in such type of frameworks. We uncover and study the following policy tradeoff: infrastructure investment expansions may have the largest impact on GDP when targeted to the highest productivity sector, but they may also increase income

*The author is grateful to discussions with Michael Kumhof, Andrew Berg, Catherine Patillo, Felipe Zanna and Mihaela Pintea. The views expressed herein do not necessarily reflect those of the IMF, the Federal Reserve Bank of St. Louis, or the Federal Reserve System.

inequality, and even depress the income of the poorest. The reason is that such expansions require increased production of non agricultural goods. General equilibrium forces may lower the price and ultimately the income of agriculture to accommodate the required shift of resources. Labor reallocation frictions prevent equalization of wages across sectors. Further, wage and relative price movements may be large, due to the highly inelastic demand for agriculture when output is close to subsistence levels.

Keywords: Infrastructure spending, fiscal policy, multiplier, structural transformation.

J.E.L. codes: E2, H3, H54, Q1.

1 Introduction

We develop a dynamic general equilibrium framework to study some of the interconnections between fiscal policy, macroeconomic performance, and the distribution of income in low income countries (LIC). Low income economies posses a number of features that matter for such interconnections, and we incorporate them explicitly in our analysis. First, LIC have a very large agricultural sector. More important, in spite of the large employment share of agriculture, productivity in this sector is known to be orders of magnitude lower than in other sectors. These observations, and a large body of empirical literature, suggest the presence of frictions keeping productivity low and preventing sectoral reallocation [cf. Herrendorf, Rogerson and Valentinyi (2011)]. Second, government infrastructure is relatively scarce. Third, in spite of the fact that foreign aid is some times available and that it maybe large (in comparison to tax revenue) absorption capacity constraints limit the effectiveness of infrastructure investment [cf. Berg et. al. (2010)]. Finally, financial systems have limited penetration, which complicates the free flow into entrepreneurship as well as the ability of smoothing consumption.

Our analytical tool is a multi-sector model that includes an agricultural, a natural resource, and a non-agricultural sector, as well as a government. Production is undertaken by an exogenously given set of households, who are entrepreneurs and require capital, labor, and land as inputs. Capital and land are sector specific, and labor is subject to reallocation frictions. Land is exogenously allocated, reflecting regulations and other land holding constraints. The government may receive international aid, which together with tax revenues is used to fund government consumption and infrastructure investment. Infrastructure affects the productivity of private production functions.

LIC features bring about new and interesting tradeoffs to policy analysis. The impact of government expenditure depends strongly on its sectoral composition, and also on the general equilibrium effects due to labor reallocation and absorption frictions. We uncover and study the following policy tradeoff: infrastructure investment expansions may have the largest impact on GDP when targeted to the highest productivity sector, but they may also increase income inequality, and even depress the income of the poorest. The reason is that such expansions require increased production of non agricultural goods. General equilibrium forces may lower the price and income of agriculture to accommodate such reallocation. These movements may be large, given the highly inelastic demand for agricultural goods that occurs close to subsistence levels. Finally, we explore the relation between sectoral reallocation frictions and the magnitude of the government expenditure multiplier.

2 The Model

There are three commodities: an agricultural good, natural resources, and a non-agricultural good. The non-agricultural good will be the numeraire.

Production of the agricultural good requires land, L^a, and labor, N^a. Production (or extraction) of natural resources requires land, L^r, capital, K^r, and labor N^r. We abstract from capital in the agricultural sector as a reduced form for the fact that most agricultural production in LIC is subsistence level. Industrial agricultural goods (mostly for export) could be mapped into the natural resources sector, if desired. The non-agricultural good is produced employing capital and labor, K^o, N^o. Capital and land are assumed to be sector specific, and, as is standard, investment will be assumed irreversible. Assuming land is sector specific is an approximation to government controls on land holdings. The production functions of each sector will be denoted by F^j, for $j = a, r, o$.

Production technologies may also be influenced by the stock of government capital K^g, which can be identified with infrastructure. The stock of government capital and its law of motion are taken as given by all private agents. Sectoral productivities, aid, and the international price of natural resources may be random. Hence, time indices below stand for date-events.

There are three types of agents: (1) A government, which taxes income, may receive foreign aid and employs its revenues to fund exogenously given sequences of infrastructure investment and government consumption; (2) entrepreneurs, who are the owners of private capital and are the residual claimants of income (after the wage bill and investment); and (3) workers, who rent their labor time to entrepreneurs but cannot accumulate capital.

Entrepreneurs and workers receive utility from consuming both, the agricultural good and the non-agricultural good, $c^{a,l}, c^{o,l}$, respectively. For lack of better notation, the second super index here denotes the type of agent $l = e$(ntrepreneurs),w(orkers). Following the literature, we will assume preferences are non-homothetic in the agricultural good so that its income elasticity is less than one.

For now, we assume the supply of labor is fixed and equal to N, and assume it is costly to reallocate labor across sectors. Hence, available hours must be divided between actual hours worked in a given industrial sector, N^j, and time devoted to reallocating the labor force.

$$N_t^a + N_t^o + N_t^r + \Gamma^a(N_t^a - N_{t-1}^a) + \Gamma^o(N_t^o - N_{t-1}^o) + \Gamma^r(N_t^r - N_{t-1}^r) = N \quad (1)$$

where each of the functions Γ^i is positive, convex, and equal to zero at 0.

Factor markets are competitive. The wage and interest rates are w^j, i^j, respectively, for $j = a, r, o$. The government taxes labor income for workers according to function $T^N(w^a N^a, w^o N^o, w^r N^r)$. This general specification allows for differential labor income taxes in each sector. Similarly, capital income, π^j, is taxed according to function $T^K(\pi^a, \pi^r, \pi^o)$.

Workers cannot hold capital but may save/borrow using domestic bonds denominated in the non-agricultural good, b. There is no possibility of default. The problem of the workers is thus to maximize

$$E_0 \sum_t \beta^t u(c_t^{a,w}, c_t^{o,w})$$

subject to their budget constraint

$$p_t^a c_t^{a,w} + c_t^{o,w} + (1+r_t) b_t^w = b_{t+1}^w + w_t^a N_t^a + w_t^o N_t^o + w_t^r N_t^r - T_t^N (w_t^a N_t^a, w_t^o N_t^o, w_t^r N_t^r),$$

an exogenous (for now) borrowing constraint

$$b_{t+1}^w \geq -B^w,$$

and the labor reallocation costs described above. It may be desirable to have more than one type of worker (one type per sector, for example). A different specification for labor reallocation costs may be required to do so.

Entrepreneurs operate in competitive factor and goods markets. The price of the natural resource good, p^r, in terms of the non-agricultural good is determined in international markets. Hence, the economy is "small and open" with respect to this good. To simplify the analysis we assume investment goods are also produced by the non-agricultural goods sector. The problem of entrepreneurs is thus to maximize

$$E_0 \sum_t \beta^t u(c_t^{a,e}, c_t^{o,e})$$

subject to

$$\begin{gathered}
p_t^a c_t^{a,e} + c_t^{o,e} + x_t^{r,e} + x_t^{o,e} + (1+r_t) b_t^e = b_{t+1}^e + \pi_t^r + \pi_t^o + \pi_t^a - T_t^K (\pi_t^a, \pi_t^r, \pi_t^o) \\
\pi_t^j = p^j F^j - w^j N^j,\ j = a, o, r \\
K_{t+1}^j = x_t^j + (1-\delta^j) K_t^j, \quad j = o, r \\
x_t^j \geq 0,\ j = o, r \\
b_{t+1}^e \geq -B^e.
\end{gathered}$$

Finally, we have the government, which must fund exogenously given sequences of government investment, $x_t^G \geq 0$, with $K_{t+1}^G = x_t^G + (1-\delta^G)K_t^G$, and ordinary expenditures (at later stages we may consider the problem of choosing optimal government spending, which would be particularly interesting after sectoral shocks). Total government expenditure is thus $\Omega^o(c_t^{o,G}+x_t^G)$. Absorption capacity is summarized by functions $\Omega(x) \geq x$ for all x, so that the government spends more resources than the actual purchases received. The sources of funds of the government are foreign aid, A_t, and taxes. We impose a balanced budget constraint. Observe that labor and capital income taxes T_t^N, T_t^K are functions of the given date event so that lump-sum transfers are, in principle, available to guarantee balanced budget.

The aggregate resource constraints of this economy are, the time constraints (1) and

$$
\begin{aligned}
c^{a,e} + c^{a,w} &= F^A \\
c^{o,e} + c^{o,w} + x^{r,e} + x^{o,e} + \Omega^o(c_t^{o,G} + x^G) &= F^o + p^r F^r + A.
\end{aligned}
$$

3 Policy, income distribution, and macroeconomic activity in "constrained planner" economies

To develop intuition, our quantitative analysis starts from a simple benchmark economy where taxes are lump sum and debt constraints not binding. Allocations of such an economy will be constrained Pareto optima and thus map into a planner's problem, with the appropriate lifetime utility weights for workers and entrepreneurs. Also, we consider deterministic economies and their impulse responses to unexpected changes in government expenditures or commodity price booms and busts. Commodity prices, aid flows, and infrastructure and government consumption expenditures are taken as given. The shadow "relative price" of the agricultural good is the ratio of marginal utilities between consumption of agriculture and non-agricultural goods, $p^{a*} = u_{c^o}/u_{c^a}$.

Our first application computes the magnitude of government expenditure multiplier in two different circumstances: (a) a change in government expenditure, holding all other factors and parameter values constant; and (b) changes in government expenditure under alternative aggregate and/or sectoral shocks.

The planner's problem is choosing private consumption and investment allocations that solve

$$\max \lambda^w \textstyle\sum_t \beta^t u(c_t^{a,w}, c_t^{o,w}) + (1-\lambda^w) \textstyle\sum_t \beta^t u(c_t^{a,e}, c_t^{o,e})$$

s.t.

$$c^{a,e} + c^{a,w} = F^A \tag{2}$$

$$c^{o,e} + c^{o,w} + x^{r,e} + x^{o,e} + \Omega(c_t^{o,G} + x^G) = F^o + p^r F^r + A \tag{3}$$

$$K_{t+1}^o = x_t^o + (1-\delta^o) K_t^o \tag{4}$$

$$K_{t+1}^r = x_t^r + (1-\delta^r) K_t^r \tag{5}$$

$$0 \leq x_t^o \tag{6}$$

$$0 \leq x_t^r \tag{7}$$

$$N = N_t^a + N_t^o + N_t^r + \Gamma^a(N_t^a - N_{t-1}^a) + \Gamma^o(N_t^o - N_{t-1}^o) + \Gamma^r(N_t^r - N_{t-1}^r) \tag{8}$$

3.1 Properties of the planner's solution

3.1.1 Characterization

The first order necessary conditions of the planner's problem are:

$$N_t^a: \quad \gamma_t^8 = \tfrac{1}{(1+d\Gamma^a(N_t^a - N_{t-1}^a))}[\gamma_{t+1}^8 d\Gamma^a(N_{t+1}^a - N_t^a) + \gamma_t^2 F_{N_t^a}^A]$$
$$N_t^o: \quad \gamma_t^8 = \tfrac{1}{(1+d\Gamma^o(N_t^o - N_{t-1}^o))}\left[\gamma_{t+1}^8 d\Gamma^o(N_{t+1}^o - N_t^o) + \gamma_t^3 F_{N_t^o}^o\right]$$
$$N_t^r: \quad \gamma_t^8 = \tfrac{1}{(1+d\Gamma^r(N_t^r - N_{t-1}^r))}\left[\gamma_{t+1}^8 d\Gamma^r(N_{t+1}^r - N_t^r) + \gamma_t^3 p^r F_{N_t^a}^r\right]$$

$$\begin{aligned}
c^{a,w}: &\quad \lambda^w \beta^t u_{c_t^{a,w}} = \gamma_t^2 \\
c^{a,e}: &\quad (1-\lambda^w)\beta^t u_{c_t^{a,e}} = \gamma_t^2 \\
c^{o,w}: &\quad \lambda^w \beta^t u_{c_t^{o,w}} = \gamma_t^3 \\
c^{e,w}: &\quad (1-\lambda^w)\beta^t u_{c_t^{a,e}} = \gamma_t^3
\end{aligned}$$

$$\begin{aligned}
x^o: &\quad \gamma_t^3 = \gamma_t^4 + \gamma_t^6 \\
x^r: &\quad \gamma_t^3 = \gamma_t^5 + \gamma_t^7 \\
K_{t+1}^o: &\quad \gamma_{t+1}^3 F_{K_{t+1}^o}^o + (1-\delta^o)\gamma_{t+1}^4 = \gamma_t^4 \\
K_{t+1}^r: &\quad \gamma_{t+1}^3 p_{t+1}^r F_{K_{t+1}^r}^r + (1-\delta^r)\gamma_{t+1}^5 = \gamma_t^5
\end{aligned}$$

3.1.2 Steady State

We look for an equilibrium where labor, capital and consumption are all constant through time. This requires constant commodity prices, of course. Since capital is constant irreversibility does not bind. This equilibrium is characterized by

$$\lambda^w u_{c^{a,w}} = (1-\lambda^w) u_{c^{a,e}}$$
$$\lambda^w u_{c^{o,w}} = (1-\lambda^w) u_{c^{o,e}}$$

$$\beta(F_{K_{t+1}^o}^o + (1-\delta^o)) = 1 \tag{2}$$
$$\beta(p^r F_{K^r}^r + (1-\delta^r)) = 1 \tag{3}$$

$$\frac{(1+d\Gamma^o(0))}{(1+d\Gamma^a(0))}[\beta\zeta^8 d\Gamma^a(0)+\lambda^w u_{c_t^{a,w}}F^A_{N_t^a}]=\left[\zeta^8 d\Gamma^o(0)+\lambda^w u_{c_t^{o,w}}F^o_{N_t^o}\right]$$
$$\frac{(1+d\Gamma^r(0))}{(1+d\Gamma^o(0))}\left[\beta\zeta^8 d\Gamma^o(0)+\lambda^w u_{c_t^{a,w}}F^o_{N_t^o}\right]=\left[\zeta^8 d\Gamma^r(0)+\lambda^w u_{c_t^{o,w}}p^r F^r_{N_t^a}\right]$$
$$\zeta^8=\frac{\beta}{(1+d\Gamma^a(0))}[\zeta^8 d\Gamma^a(0)+\lambda^w u_{c_t^{a,w}}F^A_{N_t^a}]$$
$$N^a+N^o+N^r=N$$

and all aggregate feasibility constraints. Note that if the cost reallocation functions are the same then the labor conditions reduce to

$$u_{c^{a,w}}F^A_{N^a}=u_{c^{o,w}}F^o_{N^o} \tag{4}$$
$$p^r F^r_{N^r}=F^o_{N^o.} \tag{5}$$

Similarly, if the capital depreciation rates are the same in the non-agricultural and in the agricultural sector we have

$$p^r F^r_{K^r}=F^o_{K^o_{t+1}}.$$

This immediately implies that the capital labor ratios of these sectors will be independent of government infrastructure as long as the latter enters in a symmetric way across the two sectors. This will not be the case for agriculture due to the relative price effect and the non-homothetic preferences.

Assumptions about functional forms are required to make any further progress. We let

$$u=\log(c^a-\bar{a})+\mu\log(c^o).$$

Here, $\bar{a}$ is the subsistence level of the agricultural good. Under this specification, feasibility in agriculture requires

$$c^{a,e}+c^{a,w}=F^A$$

Production functions will be such that in a decentralized equilibrium individual production units perceive a constant returns to scale technology, but that in effect have a productivity affected by government capital. The impact of government capital is subject to congestion effects. We let

$$F^x = z^x f^x,$$

with f a constant returns to scale technology in inputs. Further

$$z^x = Z^x \left(\frac{K^g}{f^x}\right)^{\gamma^x},$$

with $0 \leq \gamma^x < 1$. Hence, the planner's production function is constant returns to scale and it is given by: $F^x = Z^x \left(K^g\right)^{\gamma^x} \left(f^x\right)^{1-\gamma^x}$.

We now impose a Cobb-Douglas specification for f^x, and assume $\gamma^x = \gamma$ for all x:

$$\begin{aligned} F^A &= z^a (K^G)^\gamma \left((N^a)^{\alpha_a} \left(L^a\right)^{1-\alpha_a}\right)^{1-\gamma} \\ F^o &= z^o (K^G)^\gamma \left((N^o)^{\alpha_o} \left(K^o\right)^{1-\alpha_o}\right)^{1-\gamma} \\ F^R &= z^R (K^G)^\gamma \left(\left(N^R\right)^{\alpha_R^1} (K^R)^{\alpha_R^2} (L^R)^{1-\alpha_R^1-\alpha_R^2}\right)^{1-\gamma}. \end{aligned}$$

Under all of the previous specification for functional forms we have, first

$$\begin{aligned} \tfrac{\lambda^w}{c^{a,w}-\bar{a}} &= \tfrac{(1-\lambda^w)}{c^{a,e}-\bar{a}} \\ \tfrac{\lambda^w}{c^{o,w}} &= \tfrac{(1-\lambda^w)}{c^{o,e}}. \end{aligned}$$

It follows that consumption of the agricultural good is given by

$$\begin{aligned} c^{a,e} &= \tfrac{(1-\lambda^w)}{\lambda^w} c^{a,w} - \tfrac{(1-2\lambda^w)}{\lambda^w} \bar{a} \\ c^{a,w} &= \lambda^w (F^A) + (1-2\lambda^w)\bar{a} \end{aligned} \tag{6}$$

so that

$$c^{a,e} = (1-\lambda^w)(F^A) - (1-2\lambda^w)\bar{a}. \tag{7}$$

Similarly,

$$c^{o,e} = \tfrac{(1-\lambda^w)}{\lambda^w} c^{o,w}$$

$$c^{o,w} = \lambda^w \left(F^o + p^r F^r + A - \delta^r K^r - \delta^o K^o - \Omega(c_t^{o,G} + \delta^G K^G) \right) \tag{8}$$

$$c^{o,e} = (1-\lambda^w) \left(F^o + p^r F^r + A - \delta^r K^r - \delta^o K^o - \Omega(c_t^{o,G} + \delta^G K^G) \right) \tag{9}$$

Notice that $p^{a*} = \mu \frac{c^{a,e}-\overline{a}}{c^{o,e}}$ so that the previous equations define consumptions as function of capital, labor and the planner's weight of each group of agents.

Equalization of marginal products of labor and capital across sectors o and R imply

$$\frac{\alpha_R^2}{\alpha_R^1} \frac{N^R}{K^R} = \frac{1-\alpha_o}{\alpha_o} \frac{N^o}{K^o}. \tag{10}$$

Hence, equations (1)-(9) define a non-linear system with 9 unknowns: $N^a, N^o, N^R, c^{a,w}, c^{o,w}, c^{a,e}, c^{o,e}, K^o, K^R$.

3.1.3 Dynamics

The planner's FOCS imply consumption allocation rules

$$u_{c_t^{a,w}} = \tfrac{(1-\lambda^w)}{\lambda^w} u_{c_t^{a,e}}$$
$$u_{c_t^{o,w}} = \tfrac{(1-\lambda^w)}{\lambda^w} u_{c_t^{o,e}};$$

which, under the assumption of separability in the utility function yield $c^{a,w}, c^{o,w}$ as functions of $c^{a,e}, c^{o,e}$. Using feasibility, we can solve for all private consumptions as functions of capital tomorrow and current labor allocations.

Then, optimality for investment and capital results in standard looking Euler equations:

$$\beta u_{c_{t+1}^{o,e}} F^o_{K^o_{t+1}} + (1-\delta^o)(\beta u_{c_{t+1}^{o,e}} - \zeta_{t+1}^6) = u_{c_t^{o,e}} - \zeta_t^6$$
$$\beta u_{c_{t+1}^{o,e}} p_{t+1}^r F^r_{K^r_{t+1}} + (1-\delta^r)(\beta u_{c_{t+1}^{o,e}} - \zeta_t^7) = u_{c_t^{o,e}} - \zeta_t^7,$$

which depend only on capital in periods $t, t+1, t+2$, and labor in periods $t, t+1$. Here, the multipliers of investment irreversibility are $\zeta_t^x = \frac{\gamma_t^x}{(1-\lambda^w)\beta^t}$, for $x = 6, 7$, and are strictly positive only when irreversibility binds.

Now, the optimality conditions for labor work as follows. Eventually, the model converges to a situation with no reallocation. If we let $\zeta_t^8 = \frac{\gamma_t^8}{\beta^t}$ we then have 4 equations

$$
\begin{gathered}
\frac{(1+d\Gamma^o(0))}{(1+d\Gamma^a(0))}[\beta\zeta_{t+1}^8 d\Gamma^a(0) + \lambda^w u_{c_t^{a,w}} F_{N_t^a}^A] = \left[\zeta_{t+1}^8 d\Gamma^o(0) + \lambda^w u_{c_t^{o,w}} F_{N_t^o}^o\right] \\
\frac{(1+d\Gamma^r(0))}{(1+d\Gamma^o(0))}\left[\beta\zeta_{t+1}^8 d\Gamma^o(0) + \lambda^w u_{c_t^{a,w}} F_{N_t^o}^o\right] = \left[\zeta_{t+1}^8 d\Gamma^r(0) + \lambda^w u_{c_t^{o,w}} p^r F_{N_t^a}^r\right] \\
\zeta_t^8 = \frac{\beta}{(1+d\Gamma^a(0))}[\zeta_{t+1}^8 d\Gamma^a(0) + \lambda^w u_{c_t^{a,w}} F_{N_t^a}^A] \\
N^a + N^o + N^r = N
\end{gathered}
$$

and four unknowns N^a, N^r, N^o, ζ^8. If t is a period where labor reallocation takes place we have that N_{t+1}^i, ζ_{t+1}^8 are given, and we need to solve for ζ_t^8, N_t^i from the four equations

$$
\begin{gathered}
\zeta_t^8 = \frac{1}{(1+d\Gamma^a(N_t^a - N_{t-1}^a))}[\zeta_{t+1}^8 d\Gamma^a(N_{t+1}^a - N_t^a) + \lambda^w u_{c_t^{a,w}} F_{N_t^a}^A] \\
\zeta_t^8 = \frac{1}{(1+d\Gamma^o(N_t^o - N_{t-1}^o))}\left[\zeta_{t+1}^8 d\Gamma^o(N_{t+1}^o - N_t^o) + \lambda^w u_{c_t^{o,w}} F_{N_t^o}^o\right] \\
\zeta_t^8 = \frac{1}{(1+d\Gamma^r(N_t^r - N_{t-1}^r))}\left[\zeta_{t+1}^8 d\Gamma^r(N_{t+1}^r - N_t^r) + \lambda^w u_{c_t^{o,w}} p^r F_{N_t^a}^r\right] \\
N = N_t^a + N_t^o + N_t^r + \Gamma^a(N_t^a - N_{t-1}^a) + \Gamma^o(N_t^o - N_{t-1}^o) + \Gamma^r(N_t^r - N_{t-1}^r)
\end{gathered}
$$

4 Quantitative analysis

4.1 Calibration

We follow standard procedures and set parameter values so that the model in steady state matches key long run ratios for an average of poor countries in Africa.

- Agriculture captures 60% of the labor force

- $K^G/GDP = 0.4$
- $\gamma = 0.03$ so that multiplier in frictionless economy is about 1.2
- $P^r F^r / F^o = 0.5$
- 50% labor share in natural resources
- 2/3 labor share in manufacturing
- 6% capital depreciation, $\beta = 0.95$

Further details and data sources to be added.

4.2 The quantitative experiments

We depart from a steady state. We evaluate the impulse response of an unexpected increase in the stock of infrastructure of 1% that lasts for different number of periods and then fades down back to steady state levels. Agents perfectly foresee the sequence of exogenous infrastructure investments. In the baseline case the duration of the expansion is 3 years.

- Focus on
  - impact on aggregates (GDP, consumption)
  - the distribution of income (wages by sector, capital income)
  - change in the asset position of households
  - fiscal multipliers
- Across economies that differ by labor reallocation costs and $\bar{a}$

4.3 Results

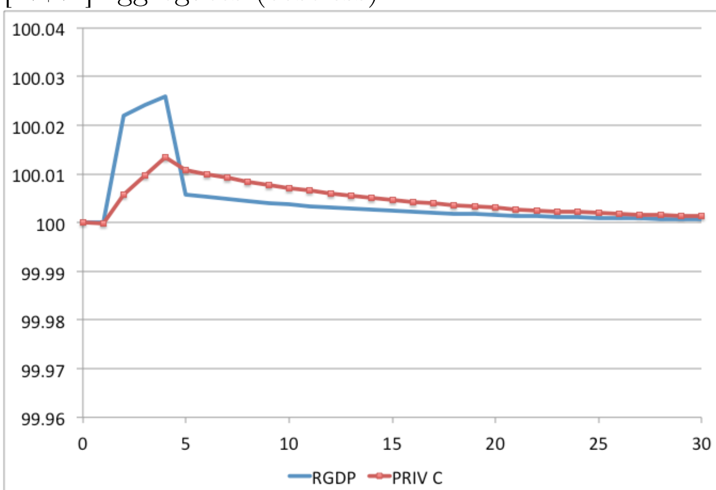
The equilibrium time series that result from an exogenous increase in infrastructure investment are summarized by the figures below. For ease of comparison, all variables have been normalized to equal 100 in steady state. The parameter determining the impact of government infrastructure on private productivity, $\gamma^x = 0.03$. This means, that, absent general equilibrium effects one should expect a 0.03% change in GDP from an expansion of 1% in infrastructure. In equilibrium, the numbers are actually not too far from this simple growth accounting prediction. It is interesting to note that, at least in GDP, the economy subject to labor reallocation frictions and that one where labor can move freely across sectors look extremely similar. As we discuss now, this similarity hides large discrepancies in income distribution.

The behavior of labor is as expected. Higher infrastructure investment requires higher production of the numeraire. The numeraire can be obtained either by higher domestic production, or by increasing exports of natural resources, which are paid by the foreign sector in units of the numeraire. Given the labor supply is fixed, all of this must come at the expense of reduced hours in agriculture. When comparing the economy without labor reallocation frictions to the one with frictions we note that movements in labor are smaller and much smoother in the economy subject to costs, which is perfectly reasonable.

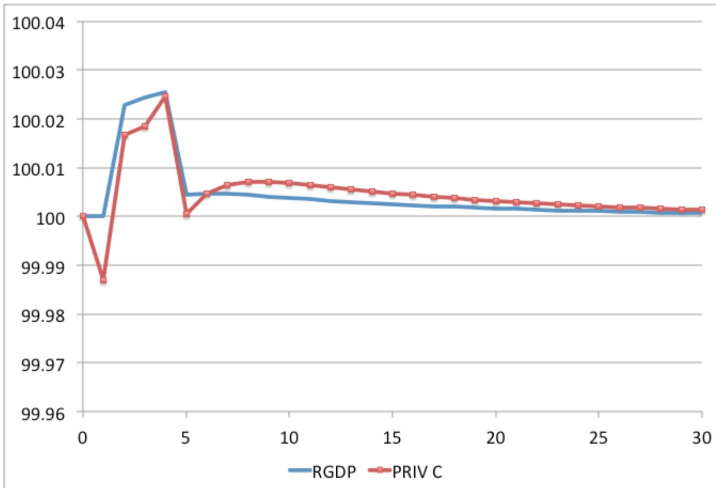
Regarding the distribution of total income per sector, differences in shares and demand elasticities for the good result in different changes in income in each sector. Total labor income in the sector producing the numeraire increases much more than the other sectors. In fact, total labor income in agriculture falls during some of the periods that the shock impacts the economy.

Of course, total labor income is the product of hours worked and the wage rate. The equilibrium trends in wages rates are as follows. In the economy where labor can freely move all wages must equate. Wages initially fall, which reflects the drop in productivity from increasing hours with a given stock of capital in the sector producing the numeraire. In the economy with costly labor reallocation wages across sectors may differ. And they actually do so in quantitatively important ways. In particular, wages in agriculture move by an order of magnitude more than in other sectors. Most of this movement, is driven by important changes in the relative price of agriculture, which are in turn due to the inelastic demand for the good as the economy produces close to subsistence levels.

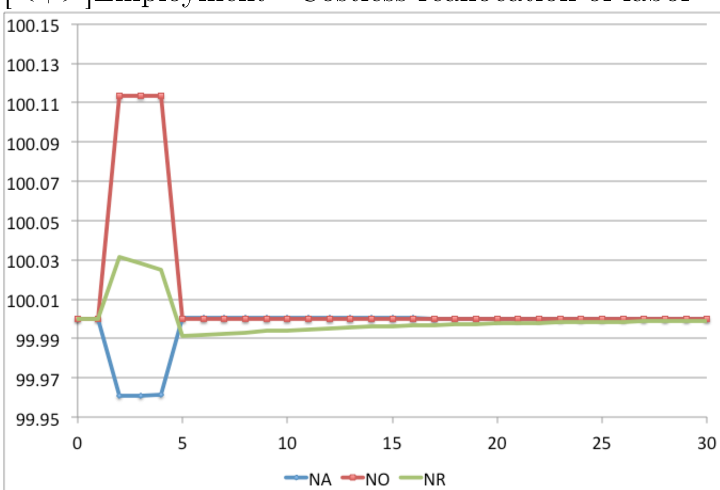
[<+>]Aggregates (costless)



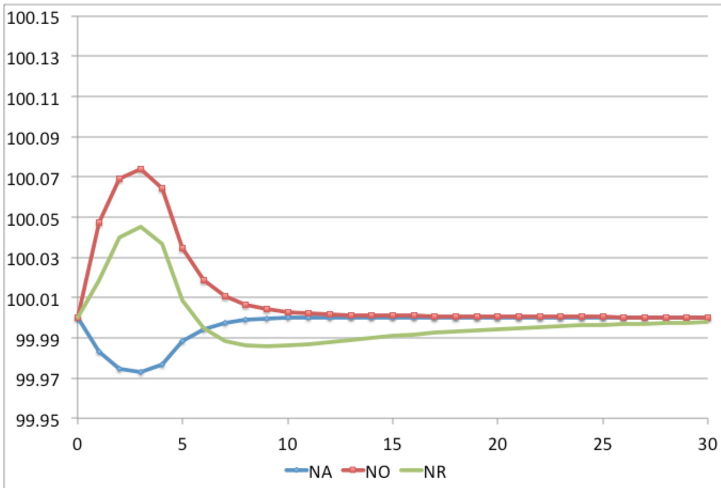
[<+>]Aggregates (costly)



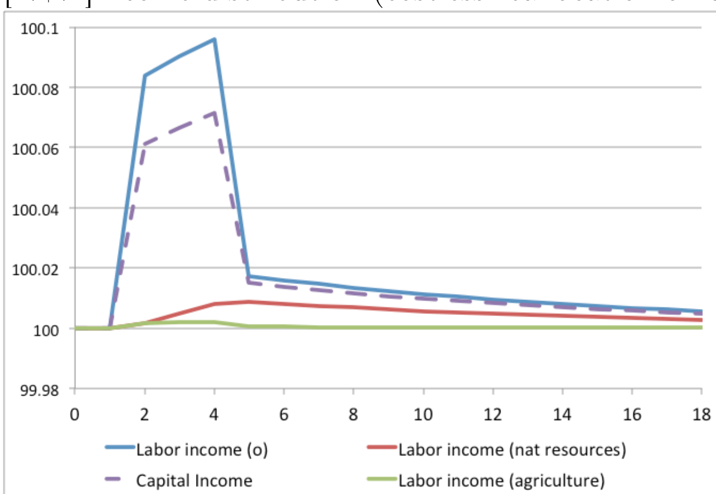
[<+>]Employment - Costless reallocation of labor



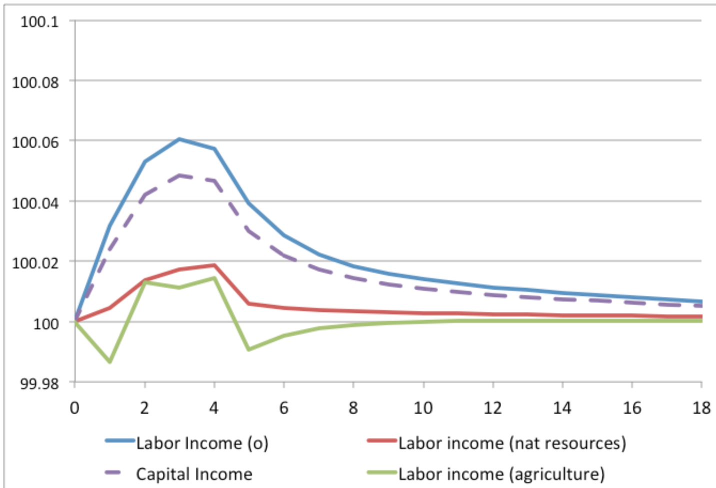
[<+>]Employment - Costly realloc.



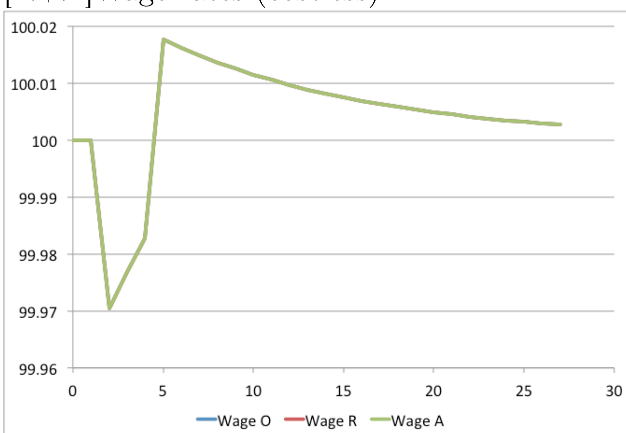
[<+>]Income distribution (costless reallocation of labor)



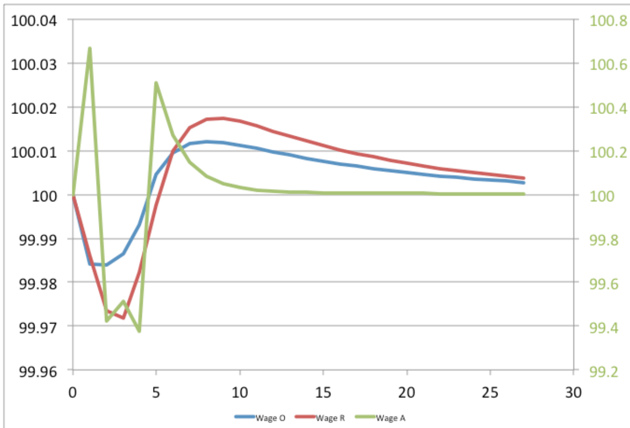
[<+>]Income distribution (costly)



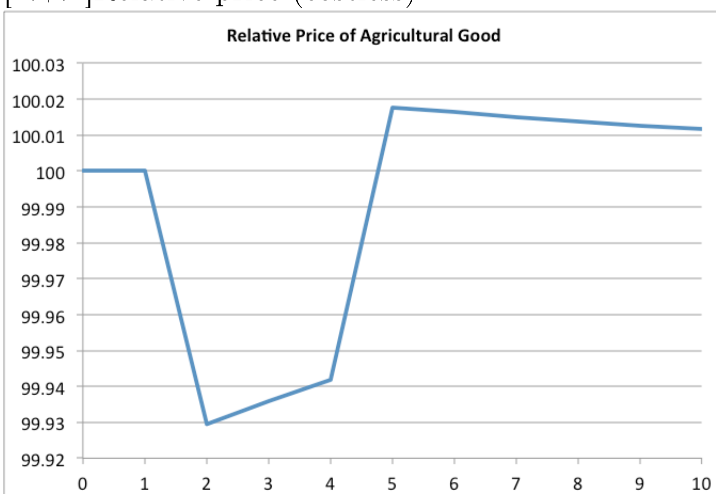
[<+>]Wage rates (costless)



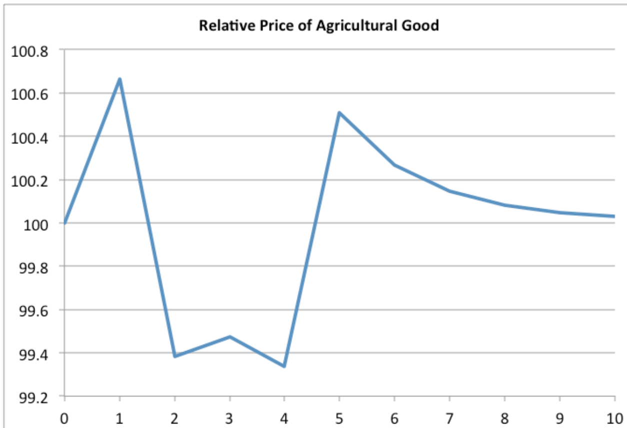
[<+>]Wage rates (costly)



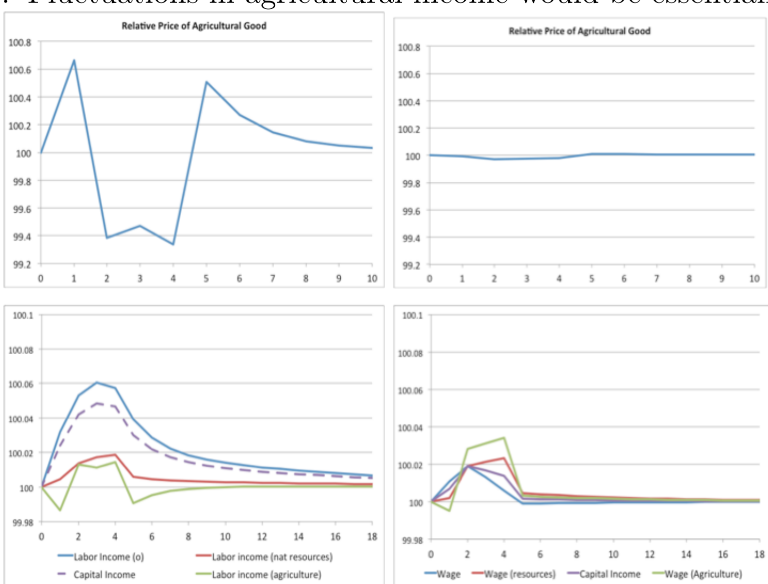
[<+>]Relative price (costless)



[<+>]Relative price (costly)



[<+>]What happens is the subsistence level of agriculture was not binding? Fluctuations in agricultural income would be essentially imperceptible.



[<+>]Multipliers

- Definition: the β in

$$\frac{y_t - y_{t-1}}{y_t} = \alpha + \beta \frac{g_t - g_{t-1}}{y_{t-1}},$$

e.g. Kraay (QJE, 2012)

- Dynamically, it is very small and negative on impact, and jumps to positive as K^g enters production.
- In the economies with $\bar{a}$ the multiplier increases with labor reallocation costs, it goes up by 4%

References

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