Sectoral Infrastructure Investments in an Unbalanced Growing Economy: The Case of Potential Growth in India*

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Abstract

We construct a two sector (agriculture and modern) overlapping generations growth model calibrated to India to study the effects of sectoral tax rates, sectoral infrastructure investments, and labor market frictions on potential growth in India. Our model is motivated by the idea that because misallocation depends on distortions, policies that reduce distortions raise potential growth. We show that the positive effect of a variety of policy reforms on potential growth depends on the extent to which public and private capital are complements or substitutes. We also show that funding higher infrastructure investments in both sectors by raising labor income taxes in the agriculture sector raises potential growth.

Keywords : Indian Economic Growth, Structural Transformation, Unbalanced Growth, Public Capital, Two-Sector OLG Growth Models, Misallocation.

JEL Codes :H2, O1, O2, O4

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1 Introduction

How do sectoral tax policies and labor laws distort the sectoral allocation of labor and capital to prevent developing economies from realizing their growth potential ? Lewis (1954) famously argued that economic development means growth of the modern sector. If so, what prevents the development and expansion of the modern sector in growing economies ? What are the impediments to the re-allocation of labor to sectors of high productivity ? Will a tax on agriculture income that funds higher public investment inhibit the rise of the modern sector ? These questions have policy importance as distortions in the agriculture and the non-agriculture (modern) sector constrain growth in developing economies by preventing the full productivity effect of factor re-allocation.

We address these questions within the context of an unbalanced growing economy, India, that is undergoing fundamental changes in the structure of production and employment. We build a two sector OLG neoclassical growth model calibrated to India. The two sectors are "agriculture" and a modern "non-agriculture" sector that merges the manufacturing and service sectors together.[1] All individuals work when young and are retired when old. Individuals pay taxes on their labor income in both sectors, and receive an excise subsidy that subsidizes consumption of agriculture products. The remaining tax revenues are allocated as infrastructure investments across both sectors. In each sectoral production technology the stock of public infrastructure is a productive input, and is combined with sector specific capital and labor in accordance with a CES production function. Public and private capital can be complements or substitutes. To incorporate the "drag" on modern sector output because of the presence of labor laws we subtract a term that increases proportionately with the size of labor employed in the modern sector. We think of this loss occurring because of bureaucratic problems related to a large labor size in the modern sector. Labor and capital are assumed to be perfectly mobile across sectors.

Given this setup, we show that exogenous fiscal policies (sectoral taxes and subsidies) and labor market frictions can play an important role in misallocating factors of production, which affects potential growth. Since less misallocation would suggest that the economy can produce more with the same factors of production and production technology, policy reforms that induce higher efficiency are key to understanding India's growth and growth potential.

1.1 India's pattern of structural transformation

Most economies have undergone substantial structural changes with large shifts of resources within agriculture, manufacturing and services and with very large changes in the capital-

[1] This identification is not necessary, as we just need two sectors whose output and employment shares in the total economy rise and fall, respectively, and whose capital-output ratios are not constant over relatively long time horizons.

output ratios in the three sectors. In the context of the developing process, India stands out for three reasons.[2] As can be seen from Figure 1, India's service sector has grown rapidly in the last three decades, constituting 55% of GDP in 2010, with the 2015 share close to 53%.[3] This large size of the service sector growth in India is comparable to the size of the service sector in developed economies where services often provide more than 60% of total output and an even larger share of employment. Since many components of services (such as financial services, business services, hotels and restaurants) are income related and increase only after a certain stage of development, it is the fact that India's service sector is very large relative to its level development that is puzzling.

[INSERT FIGURE 1]

Second, the entire decline in the share of agriculture in GDP in India in the last two decades has been picked up by the service sector with manufacturing sector's share almost remaining the same. The manufacturing share of GDP has stayed constant around 15% of GDP in India over the past 30 years.[4] In general, such a trend is experienced by high-income countries and not by developing countries. In developing countries the typical pattern is for the manufacturing sector to replace the agricultural sector at first. Only at higher levels of aggregate income does the service sector play an increasingly large role. In addition, in spite of the rising share of services in GDP and trade, there has not been a corresponding rise in the share of services in total employment. In other words, India's service sector has not adequately been employment generating.[5]

Third, unlike the case of aggregate data in advanced economies where capital-output ratios are often constant over time, the sectoral capital-output ratios in India exhibit large changes over time This is illustrated in Table 1.[6] While agriculture's capital-output ratio has fallen from 3.3 to 0.85 between 1970 and 2000, the manufacturing sector's capital-output ratio has risen from 0.6 to 4.33, and the service sector capital-output ratio has fallen from 11 to 1.82.

[2] These structural shifts are documented in Verma (2012).

[3] Industry comprises value added in mining, manufacturing, construction, electricity, and water and gas. In 2014, value added in industry was 30% of GDP. Manufacturing value added was 17% of GDP comprising approximately 57% of industry. See http://data.worldbank.org/country/india.

[4] In comparison, in 2010, manufacturing value added as a percentage of GDP was 29.5% in China, 24.8% in Indonesia, 24.5% in Malaysia, and 33.6% in Thailand (UN National Account Statistics (2015)). Gupta and Kumar (2012) provide a comprehensive review of the factors inhibiting India's manufacturing sector in the post-reform period. Hsieh and Klenow (2009) show that firm heterogeneity in productivity and distortions has lead to misallocation in Indian firms.

[5] While there will always be issues modeling three disparate sectors such as services, manufacturing, and agriculture, one can think in our and other models of economic transformation as agriculture being the one truly traditional sector and the rest of the economy as the more modern sector. These models typically capture the shrinking of the agriculture sector.

[6] See Verma (2012).

Variable	$Agr._{1970}$	$Agr._{2000}$	$Man._{1970}$	$Man._{2000}$	$Services_{1970}$	$Services_{2000}$
Employment Share	77%	62%	12%	19%	12%	20%
GDP Share	48%	25%	23%	27%	29%	48%
K/Y Ratio	3.3	.85	0.6	4.33	11	1.82
Gross Capital Formation	18%	9%	33%	30%	49%	61%
Source: Verma (2012)						

Table 1: Data on Structural Transformation in India, 1970-2000

Figure 2 shows agriculture employment in India, China and Brazil from 1980-2015. What is apparent is that the relative decline of employment's share in agriculture is slower in India compared to these countries. Taking Figure 1 and Figure 2 together, what stands out is that the changes in India's GDP structure are asymmetric to its sectoral employment intensity.

Finally, Figure 3 shows that as measured in constant 2005 dollars, the growth of India's GDP has risen persistently since 1980.

[INSERT FIGURE 2 and FIGURE 3]

1.2 Description of the main results

The observations in the previous section suggest in the context of India over the last 50 years the balanced growth assumption does not seem appropriate. First, the growth rate of GDP seems to be increasing over the sample period. Moreover, the transition out of agriculture seems to have accelerated after about 1975. We have therefore abandoned the strategy of going after balanced growth and instead pursue a strategy of just matching the transitions out of agriculture into the modern sector (manufacturing and services).[7] In our model growth will not be balanced since the production technologies do not exhibit constant returns in all the augmentable factors. In our model physical capital and infrastructure capital are augmentable. The labor's share of value added differs across the two sectors, so the returns to the two augmentable factors differs across the two sectors as well. It is this difference in the returns to augmentable factors that helps us match the transition out of agriculture into the modern sector. This transition will in general not be constant or balanced.

[7] In models of capital accumulation balanced growth typically prevails when there are constant returns to all augmentable factors. In that case all variables that can grow will grow at the same constant rate forever, and all variables that are bounded are constant over time. In growth models of structural transformation such as Gollin, Parente and Rogerson (2002) balanced growth in the sense defined above typically does not obtain since the perpetual shifting of resources from the traditional to the modern sector prevents the growth rate of GDP to be constant over time. It is still possible however to define something like balanced growth in terms of a constant rate of labor migration from the traditional to the modern sector.

Our baseline calibrations capture some of the observations discussed in Figures 1-3 for India fairly closely over a 30 year period. For instance, GDP per capita grows persistently, as in Figure 3. Second, consistent with the observations in Table 1, the agricultural sector is shrinking over time: the employment share drops from 67% to 40%, a drop of about 28%. The drop in agriculture's share of GDP is larger – dropping by about 45% – from 56% to 30%. These drops are largely consistent with the asymmetry in the data in Table 1 which show that agriculture's share of GDP in the Indian data falls more rapidly than its employment share.

Given that the baseline model captures unbalanced growth in India qualitatively, we use the calibrated version of the model to conduct a variety of counter-factual policy experiments on 1) the sectoral allocation of public infrastructure investment between the agriculture and modern sectors, 2) changes in sectoral tax rates and subsidies and 2) changes in the "drag" created by labor market frictions to increase potential growth. Our first result addresses how should public capital be allocated between the agricultural and the modern sector to influence India's growth potential. We show that a large policy reform that increases the sectoral allocation of public capital to the agriculture sector leads to smaller effects on overall GDP when public and private capital are substitutes, rather than complements. When public and private capital are substitutes, an increase/decrease in public capital is followed by a decrease/increase in private capital, thus undoing the effects of policy change. In the case of complements, a reinforcing effect takes place that magnifies the policy effects.

Second, we show that increasing the agricultural income tax rate and using the extra tax revenue to fund increased investment in infrastructure investment in both sectors .leads to a large and persistent increase in GDP. When the same experiment is conducted with a identical rise in the modern sector tax rate, the substitutability between private and public capital induces larger shifts in labor across the sectors, which translates in a larger decline in modern sector output, which, then, in turn, causes a larger decline in overall GDP.

Third, we find that an increase in the subsidy for the agricultural good shifts demand away from the modern sector to the agricultural sector This shift drags down potential growth and decreases overall GDP.

To incorporate the "drag" on modern sector output because of the presence of labor laws, following Das and Saha (2015), we subtract a term that increases proportionately with the size of labor employed in the modern sector. We think of this loss occurring because of bureaucratic problems related to a large labor size in the modern sector. We show that increasing the regulatory drag - or labor market friction - decreases wages in the modern sector and this shifts employment to agriculture. There is a drop in output in the modern and the agricultural sector, with the drop in the modern sector being larger. Since both sectoral outputs decline, overall GDP declines as well. These results are very similar when public and private capital are substitutes. This is a new interpretation of the effect of labor market frictions on sectoral infrastructure investments. Typically, in the literature, labor markets frictions are seen to employ inefficient labor in the modern sector (see Gupta and Kumar (2012) or labor market frictions constrain growth by deterring entry and skewing firm size distribution (see Alfaro and Chari, (2014)). In our model, labor market frictions depress potential output by pulling productive resources out of the modern sector. A lower value of the labor market friction parameter leads to higher efficiency suggesting that policies that diminish labor market distortions can affect potential growth.

1.3 Literature review

Our paper is related to two literatures in the field of growth and development. First, there is a large literature that studies how structural change and growth are related in the development process (see for example Caselli and Coleman (2001), Glomm (1992), Gollin, Parente and Rogerson (2002), Laitner (2000), Lucas (2004)). However, there has been relatively little work within this literature focusing on developing countries in general and India in particular.

Second, there is a large literature studying the effects of infrastructure investment on economic growth. Usually these types of analyses are carried out in a one sector growth model with an aggregate production function, often of the Cobb-Douglas kind. Examples here include Barro (1990), Turnovsky and Fischer (1995) Turnovsky (1996), Glomm and Ravikumar (1994, 1997), Eicher (2000), Agenor and Morena-Dodson (2006), Agenor (2008), Ott and Turnovsky (2006), Angelopoulus, Economides and Kammas (2007) and many others. There are also many empirical studies to go along with the above theoretical investigations. Examples of such empirical papers include papers by Barro (1990), Ai and Cassou (1995), Holtz-Eakin (1994), and Lynde and Richmond (1992).[8] To the extent that infrastructure is often seen as being strategic to development, these papers do not discuss how infrastructure spending should be financed across sectors, or whether the agriculture sector be taxed.

2 The model

The economy is populated by an infinite number of generations. Each generation is alive for two periods. The two periods are young age and old age, each accounts for 25 years. All individuals work when young and are retired when old. Within a generation all individuals are identical. For simplicity we assume that all individuals consume only in the second period

[8] Combining these two areas of growth and development research, there is a smaller literature that analyses the effects of infrastructure investment in economies undergoing structural changes such as large shifts or productive activity across from agriculture to manufacturing and then to services. Examples include Arcalean, Glomm, and Schiopu (2012), Carrera, Freire-Seren, and Manzano (2009), de la Fuente, Vives, Dolado and Faini (1995), Carminal (2004), and Ott and Soretz (2010).

of life.[9] Thus all income from the first period is saved for consumption when old. There are two sectors, one we call "agriculture" and a second sector we call "modern", although the names are not crucial. What is crucial is that there are two sectors, with one sector declining and one sector increasing along the development path. The utility function for all households is given by:

$$u(c_{m,t+1}, c_{a,t+1}) = lnc_{m,t+1} + \phi lnc_{a,t+1}, \quad \phi > 0, \tag{1}$$

where $c_{m,t+1}$ denotes the household consumption of the modern sector good and $c_{a,t+1}$ the consumption of the agricultural good.

Households working in agriculture and the modern sector solve the following problem:

$$\begin{aligned} \max_{c_m, c_a} \quad & lnc_{m,t+1} + \phi lnc_{a,t+1}, \\ s.t. \quad & c_{m,t+1} + (1-\xi)p_{t+1}c_{a,t+1} = (1-\tau_a)w_{a,t}(r_t + 1 - d) \quad \text{Agriculture} \\ & c_{m,t+1} + (1-\xi)p_{t+1}c_{a,t+1} = (1-\tau_m)w_{m,t}(r_t + 1 - d) \quad \text{Modern} \end{aligned} \tag{2}$$

where, $0 < \xi < 1$, is a government subsidy on agricultural good consumption and $\tau_a \in [0,1]$ and $\tau_m \in [0,1]$ are tax rates levied on labor income in agriculture and the modern sector, respectively. r_t represent the rental price of capital. d is depreciation rate of capital, $w_{a,t}$ is the wage rate in the agriculture sector, and $w_{m,t}$ is the wage rate in the modern sector. We assume that the modern sector good is the numeraire, and so p_t denotes the relative price of the agriculture good relative to the modern sector good.[10] Since households only consume in the second period, aggregate consumption for the agriculture good, $c_{a,t+1}$, and the modern sector good, $c_{m,t+1}$, satisfies:

$$\frac{c_{a,t+1}}{c_{m,t+1}} = \frac{\phi}{(1-\xi)p_{t+1}}. \tag{3}$$

Following Getachew and Turnovsky (2015), we assume output in each sector is produced by the production functions specified in equations (4) and (5), in which private capital and public capital are combined in accordance with the CES production function, with elasticity of substitution being, $\epsilon = 1/(1-\rho)$:

$$Y_{a,t} = A_{a,t}[a_1 K_{at}^{\rho_a} + (1-a_1)G_a^{\rho_a}]^{\theta_a/\rho_a} L_{at}^{1-\theta_a} \qquad 0 < a_1 < 1 \tag{4}$$

[9] We make the assumption that consumption only takes place when old. In that case, all income from the young is saved. This assumption generates results that are very similar to more general models where utility is derived from consumption in both periods of life, if preferences are homothetic, and, as a result, savings are a constant fraction of income. With our assumption, the savings rate happens to be constant at 100 percent.

[10] We assume that $w_{a,t}$ is inclusive of the relative price, p_t, as shown in equation (10).

$$Y_{m,t} = A_{m,t}[a_2 K_{mt}^{\rho_m} + (1-a_2) G_{mt}^{\rho_m}]^{\theta_m/\rho_m} L_{mt}^{1-\theta_m} - \gamma L_{m,t} \qquad 0 < a_2 < 1 \tag{5}$$

$$Y_t = Y_{a,t} p_t + Y_{m,t}. \tag{6}$$

Here $A_{a,t}$ and $A_{m,t}$ are total-factor-productivity (TFP) in the agricultural and modern sectors, respectively. $K_{a,t}$ and $K_{m,t}$ are the total amount of physical capital used, respectively, and $L_{a,t}$ and $L_{m,t}$ stand for the total amount of labor employed in the two sectors. $G_{a,t}$ and $G_{m,t}$ denote the stock of public capital in the agriculture and modern sectors, respectively The term, γL_{mt}, represents the labor friction in the modern sector: i.e., we subtract a term that increases proportionately with the size of labor employed in the modern sector. We think of this loss occurring because of bureaucratic problems related to a large labor size in the modern sector. This specification follows Das and Saha (2015).

We assume that investments in public infrastructure can be financed by a tax on (1) labor income in the modern sector, or (2) labor income in the agriculture sector, or (3) both. In addition to financing the public good investment, the government also subsidies consumption of agricultural products. The government budget constraint can be written as

$$G_{a,t} + G_{m,t} + \xi p_t c_{a,t} = \tau_a w_{a,t} L_{a,t} + \tau_m w_{m,t} L_{m,t} \tag{7}$$

where ξ is the subsidy for agricultural goods consumption. We do not allow public debt in our model. Letting $\delta_a \in [0, 1]$ denote the fraction of government revenue which is allocated to agricultural infrastructure, we can write

$$G_{a,t} = \delta_a[\tau_a w_{a,t} L_{a,t} + \tau_m w_{m,t} L_{m,t} - \xi p_t c_{a,t}] \tag{8}$$

$$G_{m,t} = (1-\delta_a)[\tau_a w_{a,t} L_{a,t} + \tau_m w_{m,t} L_{m,t} - \xi p_t c_{a,t}] \tag{9}$$

The returns to factors in the two sectors are:

$$w_{a,t} = p_t A_{at}[a_1 K_{at}^{\rho_a} + (1-a_1) G_{at}^{\rho_a}]^{\theta_a/\rho_a}(1-\theta_a) L_{at}^{-\theta_a} \tag{10}$$

$$w_{m,t} = A_{at}[a_2 K_{mt}^{\rho_m} + (1-a_2) G_{mt}^{\rho_m}]^{\theta_m/\rho_m}(1-\theta_m) L_{mt}^{-\theta_m} - \gamma \tag{11}$$

$$r_{a,t} = p_t A_{at} \theta_a [a_1 K_{at}^{\rho_a} + (1-a_1) * G_{at}^{\rho_a})^{\theta_a/\rho_a - 1} a_1 K_{at}^{\rho_a - 1} L_{at}^{1-\theta_a} \tag{12}$$

$$r_{m,t} = A_{at} \theta_m [a_2 K_{mt}^{\rho_m} + (1-a_2) * G_{mt}^{\rho_m})^{\theta_m/\rho_m - 1} a_2 K_{mt}^{\rho_m - 1} L_{mt}^{1-\theta_m}. \tag{13}$$

Assuming costless mobility of labor, we can equate the after tax wage rates across the two sectors,

$$(1 - \tau_a) w_{a,t} = w_{m,t} (1 - \tau_m). \tag{14}$$

Similarly, we also assume perfect capital mobility which implies

$$r_{a,t} = r_{m,t} = r_t. \tag{15}$$

For capital and labor markets, the aggregate capital K_t and aggregate labor L_t are both known at the beginning of time t,

$$\begin{aligned} K_{at} + K_{mt} &= K_t \\ L_{at} + L_{mt} &= L_t. \end{aligned} \tag{16}$$

There is no population growth in the model: $L_t = L_{t+1}$. All income is saved and funds the future capital stock

$$K_{t+1} = (1 - \tau_a) p_t w_{a,t} L_{a,t} + (1 - \tau_m) w_{m,t} L_{m,t}.$$

For the two goods market, agricultural goods can only be used for consumption Modern sector goods can be used as consumption or investment (see Cheremukhin, Golosov, Guriev, and Tsyvinski (2014)). The market clearing condition for the two goods are

$$\begin{aligned} c_{at} L_t &= Y_{at} \\ c_{mt} L_t + K_{t+1} - (1 - d) K_t + G_{t+1} &= Y_{mt}. \end{aligned} \tag{17}$$

Finally, both sectors have no direct interaction, the economy is closed, and prices are determined fully by domestic production.

3 Calibration parameters

This section describes the parameters used in our calibration exercises. Our calibration strategy is to (i) match the initial shares of sectoral employment rates, sectoral capital-output ratios, and sectoral GDP ratios, in Table 1 and (ii) the rate of decline/increase of these shares over a 30 year period as depicted in Table 1

The initial Total Factor Productivity (TFP) in agriculture (A_a) is set at 2, while that in the modern sector (A_m) is set at 1. The growth rate of agricultural TFP is 1.4, equivalent to 1.4 % annual growth; the growth rate of modern TFP is 1.3, equivalent to 1.3% annual growth. This reflects that average annual TFP growth was lower in the modern sector in

India in its earlier stages of development (Verma (2012)). In the agriculture production function, a_1 represents the weight of private capital when combined to public capital, and is set to be 0.8. Similarly, a_2 is also set at 0.8. This reflects the common observation that private capital is more important than public capital in final goods production. The CES parameters, ρ_a and ρ_m, both assume two values: 0.6 and - 0.3. If ρ = 0.6, then private capital and public capital are substitutes; if ρ = -0.3, then private and public capital are complements. In the production function, labor has a power parameter $(1-\theta)$. The crucial distinction in our model between the two sectors is capital intensity. In all the experiments below, we assume that the modern sector is more capital intensive than the agriculture sector: $\theta_m = 0.5 > \theta_a = 0.3$

We now describe the policy parameters. The government funding share for agricultural infrastructure, δ_a, is chosen to be 0.5 in the baseline model, and assumes values from 0.2 to 0.55 in the experiment. The tax rate of agricultural income, τ_a, is 0.2 in the baseline, and varies from 0.1 to 0.4 in the experiment. Similarly, the tax rate on modern sector income, τ_m, is 0.3 in the baseline, and varies from 0.1 to 0.4 in the experiment. Government subsidies of agricultural goods prices, ξ, is set at 0.1 in the baseline, but has a varying range of 0.01 to 0.15 in the experiment. Lastly, the labor friction parameter, γ, is set at zero in the baseline, and varies from 0 to 0.1 in the experiment. These values are summarized in Table 2 below.

Parameter	Definition	Baseline Value	Experiments				
ϕ	Parameter in Utility	1					
A_a	Initial TFP in Ag.	2					
A_m	Initial TFP in Man.	1					
g_a	Growth Rate of Ag. TFP (20 years)	1.4					
g_m	Growth Rate of Man. TFP (20 years)	1.3					
a_1	Capital Parameter in Ag. Production	.8					
a_2	Capital Parameter in Man. Production	.8					
ρ_a	CES Parameter in Ag. Production	.6,-.3					
ρ_m	CES Parameter in Man. Production	.6,-.3					
θ_a	Parameter in Ag. Production	.3					
θ_m	Parameter in Man. Production	.5					
Fiscal Policy							
δ_a	Gov. Infrastructure Share in Ag.	.5	{0.2,.55}				
τ_a	Tax Rate on Ag. Income	.2		{0.1, 0.4}			
τ_m	Tax Rate on Man. Income	.3			{0.1, 0.4}		
ξ	Govt. Subsidy on Ag. Prices	.1				{0.01, 0.15}	
Labor Market							
γ	Labor Market Friction	0					{0,0.1}

Table 2: Calibration Parameters

4 Policy experiments

Figure 4 depicts our calibration to Indian data assuming no labor market frictions and no subsidies. We refer to this as the baseline model. The dashed lines show the results for the complementarity assumption.[11] We assume that public capital is split evenly between the two sectors. For the calibrated version with the parameter values from Table 2 we obtain the following results First, GDP per capita grows persistently, as in Figure 3. Second, consistent with the observations in Table 1, the agricultural sector is shrinking over time: the employment share drops from 67% to 40%, a drop of about 28%. The drop in agriculture's share of GDP is larger – dropping by about 45% – from 56% to 30%. These drops are largely consistent with the asymmetry in the data in Table 1 which show that agriculture's share of GDP in the Indian data falls more rapidly than its employment share. The sizes

[11] In each experiment we show two technological cases: the case of private capital and public capital being complements (which we take to be the empirically valid assumption), and the case where they are substitutes.

of these relative drops are maintained if public and private capital are substitutes, rather than complements. The reason why overall GDP is lower when public and private capital are complements is that a limited amount of G constrains total output as this constrains the productivity of K. So overall output is less compared to the case where K and G are substitutes.[12]

[INSERT Figure 4]

One important policy issue that can fundamentally influence the growth potential is: how should public capital be allocated between the agricultural and the modern sector ? It is expected that increasing the share of public capital going to agriculture will increase agricultural output: The question is by how much. In the first policy experiment (Figure 5), we increase agriculture's share of infrastructure (δ_a) from 0.2 to 0.6. This is a very large policy reform. An immediate impact of an increase in the share of infrastructure in agriculture is that G_a increases and G_m falls. Because G and K are assumed to be complements, K_m also falls. Figure 6 reveals that GDP growth declines as more of the public capital is allocated to agriculture. This is true simply because of the higher capital (private and public) intensity of the modern sector relative to agriculture. As expected (because L_a also increases) the relative size of the agricultural sector rises, both measured in terms of employment and in terms of GDP shares, although the effect on the labor share seems to be larger than on the GDP share. The effect on the level of overall GDP is persistent, while the size of the effects on agriculture's labor share and GDP share declines over time. Finally, the effects on overall GDP are far smaller when public and private capital are substitutes. This makes sense: when public and private capital are substitutes, an increase/decrease in public capital is followed by a decrease/increase in private capital, thus undoing the effects of policy change. In the case of complements, a reinforcing effect takes place that magnifies the policy effects.

[INSERT Figure 5 and Figure 6]

In the next policy experiment we increase the agricultural income tax rate, τ_a, from 10% to 40% and use the extra tax revenue to fund increased investment (proportionately) in both types of infrastructure investment. We first consider the case of complements (Figure 7). This policy leads to a large and persistent increase in GDP. This happens for two reasons. First, the tax increase in the agriculture sector induces a large shift of labor (because of the reduction in the after tax wage) out of agriculture to the more capital intensive modern sector. Second, the increased stock of infrastructure in both sectors increases output directly, and indirectly through the productivity of capital (an augmentable factor) and labor. Of course the last effect is not there, or is at least smaller, when public and private capital

[12] An example of substitutes can be government owned machinery versus privately owned machinery. An example of complements can be private factories that rely on public infrastructure to deliver products.

are substitutes. The massive shift of labor from agriculture to the modern sector increases output in the modern sector and decreases output in agriculture. But the associated change in agriculture's share of GDP is relatively small and declining over time.

[INSERT Figure 7 and 8]

Alternatively to financing additional investment in public infrastructure the government could raise taxes on income, τ_m, in the modern sector instead. In Figure 9 we illustrate the economic effects of raising the income tax in the modern sector from 10% to 40% (an identical increase compared to τ_a in the previous case) and use the extra revenue to finance infrastructure investment proportionately to both sectors. Once again, an immediate impact of an increase in τ_m is that G_a and G_m increase. However, there is one basic benefit and one basic cost associated with this policy. The cost is a shift of labor to agriculture with its lower capital productivity. The benefit is the extra infrastructure capital. The results are: (i) When public and private capital are complements, these two effects roughly cancel each other out and, as a consequence, the effects on overall GDP are small. (ii) When public and private capital are substitutes, the effect on overall GDP is negative. The substitutability induces larger shifts in labor across the sectors, which translates in a larger decline in modern sector output, which, then, in turn, cause a larger decline in overall GDP. These results also show that funding higher infrastructure investments in both sectors by raising labor income taxes in the agriculture sector raises potential growth.

[INSERT Figure 9 and 10]]

Many poor countries maintain subsidies for agricultural products, i.e. food, and India is no exception in this regard. In Figure 11 we illustrate the effect of increasing such a subsidy. As expected we find that a higher subsidy, or an increase in ξ, leads to a reduction in G_a and G_m. We also find that: (i) the subsidy for the agricultural good shifts demand away from the modern sector to the agricultural sector. (ii) This shift drags down potential growth and decreases overall GDP.

[INSERT Figure 11 and Figure 12]

There are many reasons to believe that various regulations and labor practices in manufacturing and the service sector (the modern sector) hold back productivity to unnecessary low levels. We model this in the production function as a subtraction from output by the amount, γL_m. So far we have assumed in all the computations that this drag is zero. To investigate the effect of this regulatory drag on economic growth, we increase γ in equation (2.4) from 0.0 to 0.1. The results illustrated in Figure 13 are: (i) Increasing the regulatory drag decreases wages in the modern sector and this shifts employment to agriculture.

Because γ increases, modern sector GDP, Y_m, also falls which leads to a reduction in G_a and G_m. This is a new interpretation of the effect of labor market frictions on sectoral infrastructure investments. Typically, in the literature, labor markets frictions are seen to employ inefficient labor in the modern sector (see Gupta and Kumar (2012) or labor market frictions constrain growth by deterring entry and skewing firm size distribution (see Alfaro and Chari, (2014)) In our model, labor market frictions depress potential output by pulling productive resources out of the modern sector.

We also find that there is a drop in output in the modern and the agriculture sector, with the drop in the modern sector being larger. Since both sectoral outputs decline, overall GDP declines as well. These results are very similar when public and private capital are substitutes.

[INSERT Figure 13 and Figure 14]

4.1 Robustness

A feature of our model described in equations (1) to (17) is that the relative price of the agriculture good falls steadily. The drop of the agriculture price is a function of the Cobb-Douglas specification which has been used in many similar models. In effect, as the TFP of agriculture sector increases, the price of the agriculture product decreases. This offsets the increase in the agricultural product, $Y_{a,t}$. To adjust for this, instead of equation (6), we define output in constant prices which holds the agriculture price from the first period fixed, i.e.,

$$Y_t = p_0 Y_{a,t} + Y_{m,t}. \tag{18}$$

p_0 is endogenously determined from the system. In subsequent periods, it is kept fixed.[13] We consider one key policy experiment: an increase in agriculture income taxation. In the first period, 0,Figure (15) shows that the overall GDP level defined by equation (18) is higher corresponding to the level of GDP from equation (6). Under the fixed-price definition of GDP, the relative price of the agriculture good is invariant with respect to changes in agricultural productivity. When the relative price is flexible, it declines over time.[14]

[INSERT Figure **15**]

[13] Because of parameter sensitivity, in the fixed price definition of GDP, we change the following parameter values inTable 2: initial agricultural TFP, A_a, is set to 3; initial manufacturing TFP, A_m, is set to 1; agriculture TFP is set to 1.3%; and manufacturing TFP growth is set to 1.2%. To facilitate the GDP comparison we apply this subset of parameters for the calculation of flexible price GDP as well.

[14] The comparison between flexible price and fixed price GDP for the other policy experiments are available from the authors on request. In these, we see that the ordering of the policies that we consider by their effects on growth are invariant to the definition we use.

5 Conclusion and policy implications

We build a two sector (agriculture and modern) OLG growth model calibrated to India to examine the effect of sectoral tax policies, sectoral infrastructure investments, and labor market frictions on the sectoral allocation of labor and capital in the Indian economy. Our paper hopes to address two broad issues. First, how do sectoral tax rates and labor market frictions prevent developing economies like India from realizing their growth potential? Second, what prevents the development and expansion of the modern sector in a growing economy like India? These questions have policy importance as distortions in the agriculture and the modern sector have constrained growth in India by preventing the full productivity effect of factor re-allocation.

The calibrated model yields several policy implications: we show that a large policy reform that increases the sectoral allocation of public capital to the agriculture sector leads to smaller effects on overall GDP when public and private capital are substitutes, rather than complements. When public and private capital are substitutes, an increase/decrease in public capital is followed by a decrease/increase in private capital, thus undoing the effects of policy change. In the case of complements, a reinforcing effect takes place that magnifies the policy effects. We also show that funding higher infrastructure investments in both sectors by raising labor income taxes in the agriculture sector income raises potential growth. If the same policy reform is enacted by taxing labor income in the modern sector, potential growth increases by much less.

Finally, increasing the regulatory drag - or labor market friction - decreases wages in the modern sector and this shifts employment to agriculture. This leads to a drop in output in the modern sector and the agricultural sector, with the drop in the modern sector being larger. Since both sectoral outputs decline, overall GDP declines as well. These results are very similar when public and private capital are substitutes.

In sum, policy reforms relating to sectoral tax rates, sectoral infrastructure investments, and labor market frictions can have a sizeable affect on growth and potential growth in the Indian context.

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6 Figures

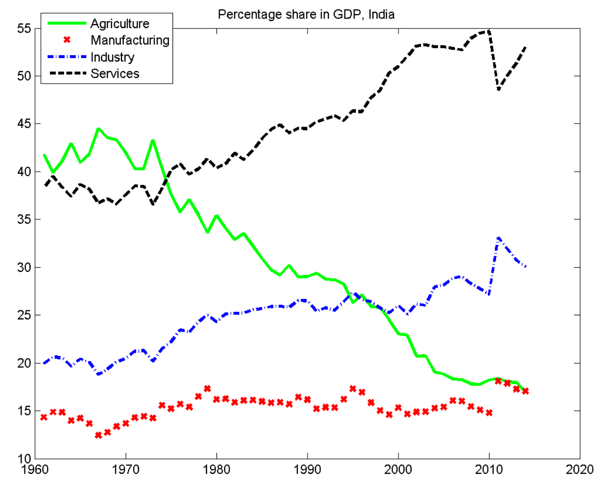

Figure 1: Structural Transformation in India

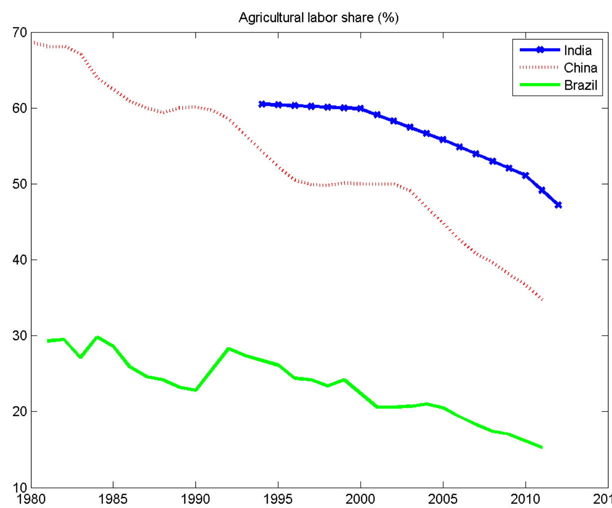

Figure 2: Agriculture employment in select EMEs

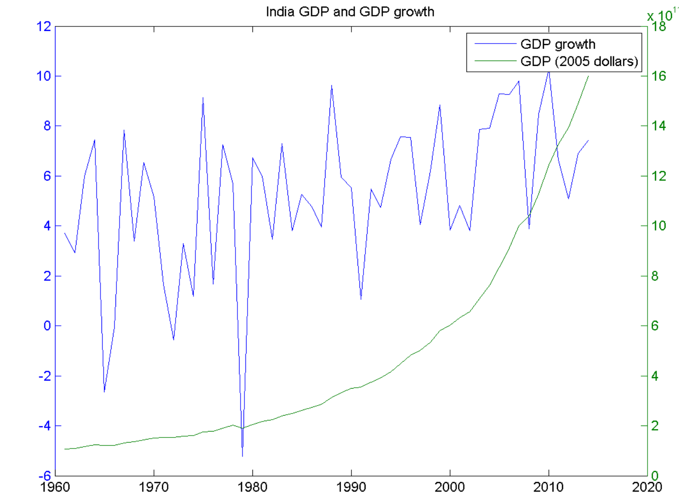

Figure 3: Indian GDP at constant 2005 prices

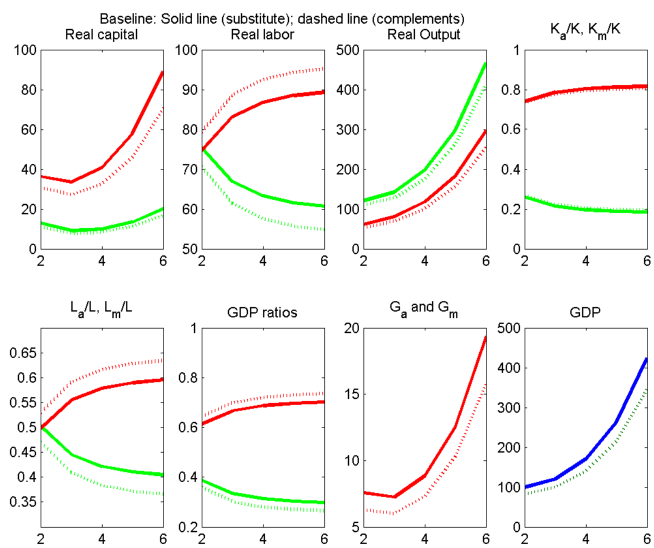

Figure 4: Baseline model: no labor market frictions, no subsidies. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

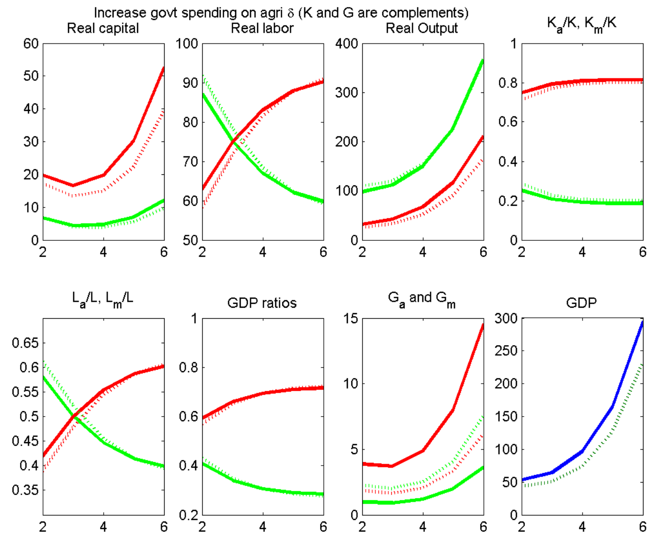

Figure 5: Policy experiment: Increase δ_a from 0.2 to 0.6; K, G complements. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

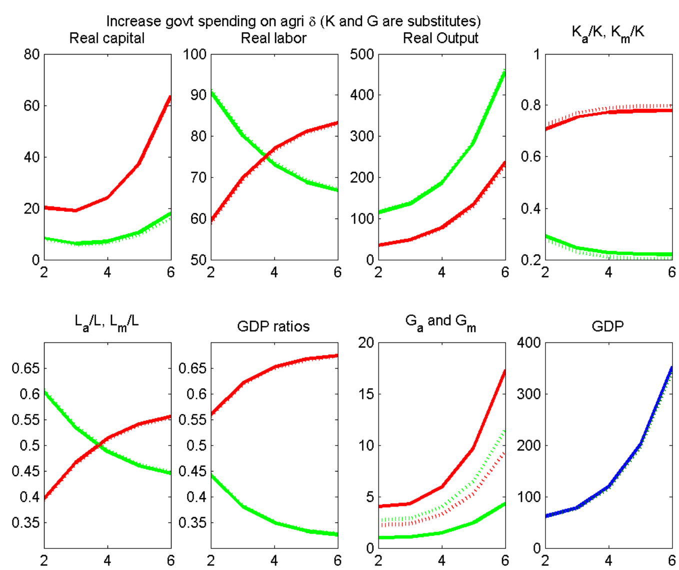

Figure 6: Policy experiment: Increase δ_a from 0.2 to 0.6; K, G substitutes. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

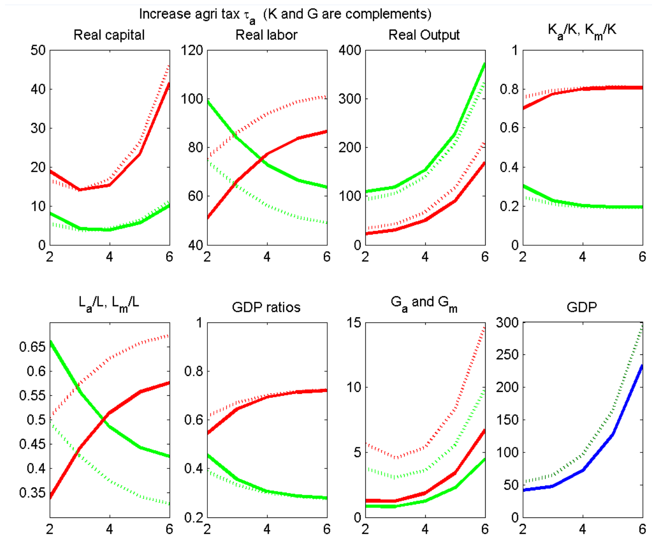

Figure 7: Policy experiment: Increase τ_a from 0.1 to 0.4, increase government expenditures proportionately in both sectors; K, G complements. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

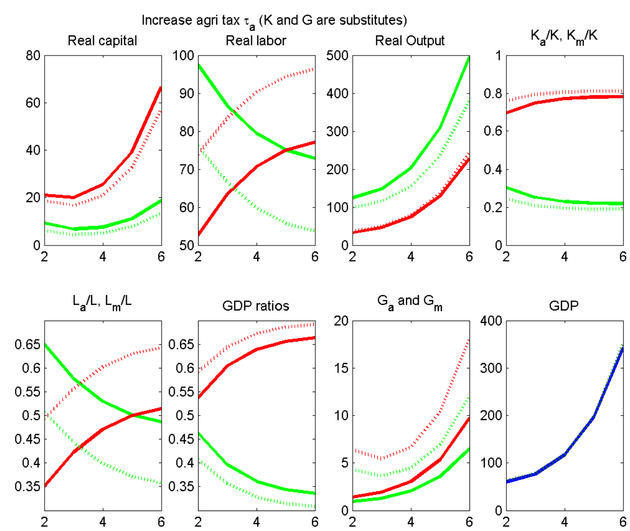

Figure 8: Policy experiment: Increase τ_a from 0.1 to 0.4, increase government expenditures proportionately in both sectors; K, G substitutes. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

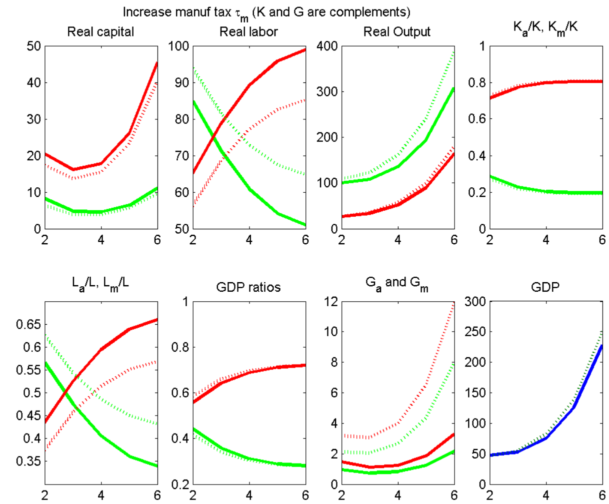

Figure 9: Policy experiment: Increase τ_m from 0.1 to 0.4, increase government expenditures proportionately in both sectors; K, G complements. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

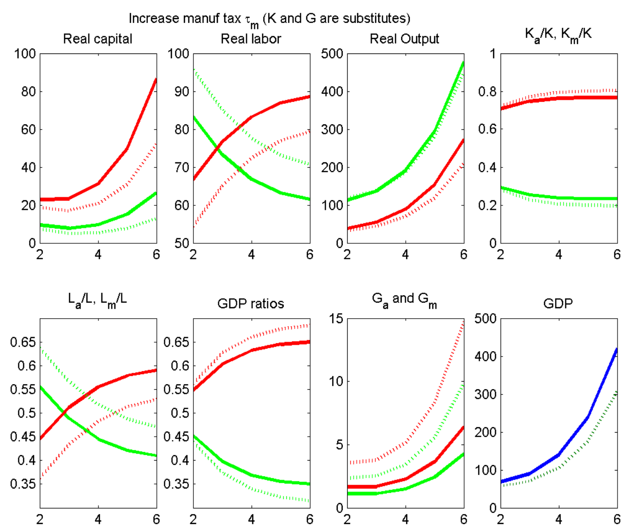

Figure 10: Policy experiment: Increase τ_m from 0.1 to 0.4, increase government expenditures proportionately in both sectors; K, G substitutes. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

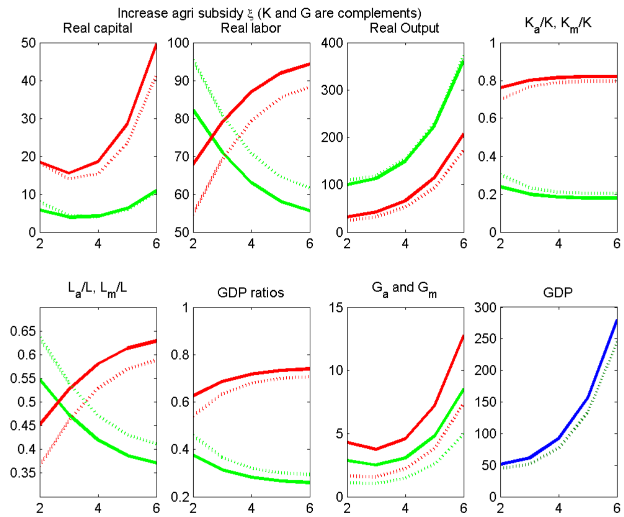

Figure 11: Policy experiment: Increase ξ from 0.01 to 0.15; K, G complements. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

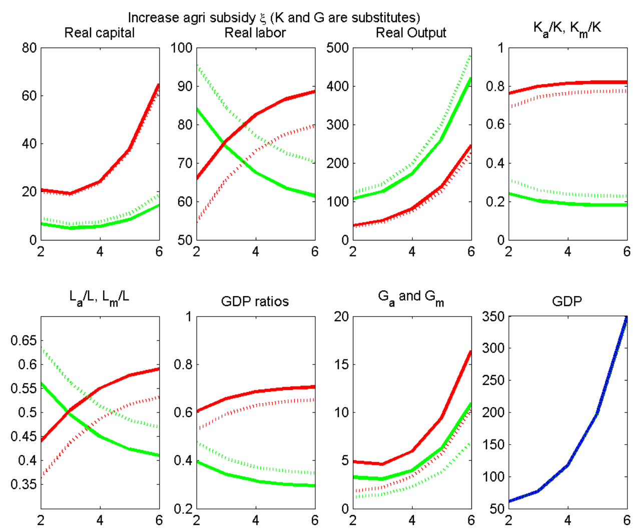

Figure 12: Policy experiment: Increase ξ from 0.01 to 0.15; K, G substitutes. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

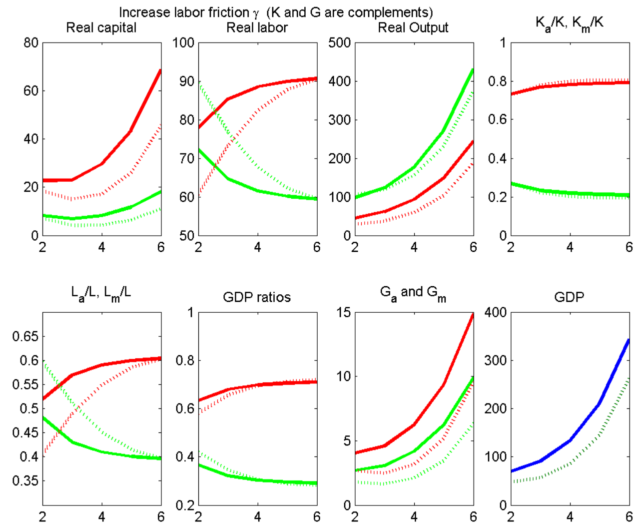

Figure 13: Policy experiment: Increase γ from 0 to 0.1; K, G complements. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

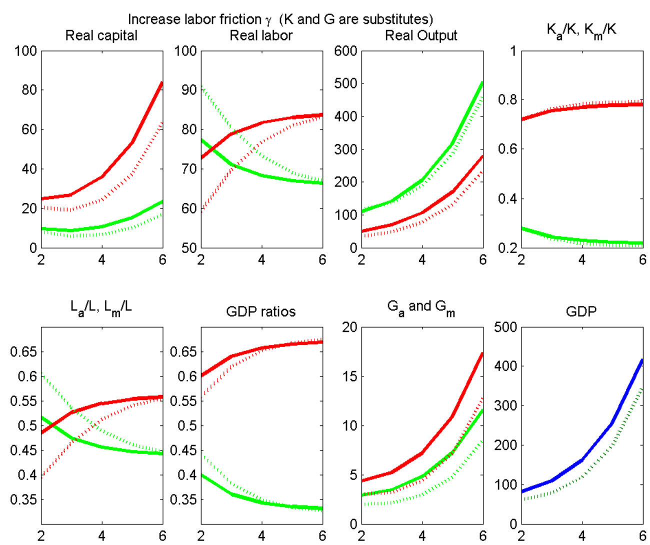

Figure 14: Policy experiment: Increase γ from 0 to 0.1; K, G substitutes. Solid lines denote before the policy experiment. Dashed lines denote after the policy experiment. Red (Modern), Green (Agriculture), Blue (Overall GDP)

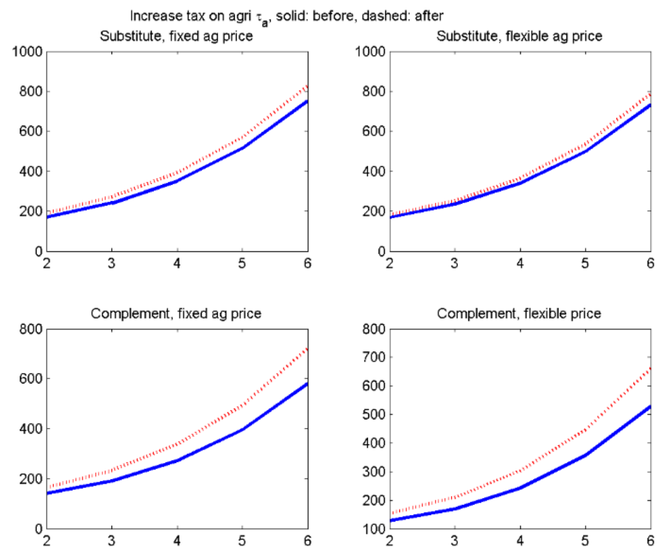

Figure 15: Comparison between fixed price GDP from equation (18) (blue line) and flexible price GDP from equation (6) (dashed red line) after τ_a increases from 0.1 to 0.4. Graphs in top row correspond to K and G being substitutes and graphs in bottom row correspond to K and G being complements.