WORKING PAPER No. 01

Structural Change and Labor Force Contraction in China at the Lewis Turning Point

By

Massimiliano La Marca

International Labor Organization

and

Xiao Jiang

International Labor Organization

Denison University

June 2021

Structural Change and Labor Force Contraction in China at the Lewis Turning Point*

Massimiliano La Marca † Xiao Jiang‡

Abstract

This paper addresses the concerns over the effects China's labor force contraction and loss of competitiveness on the economy using a 3-sector SAM based structural simulation model with rural and urban households and underemployed labor. The 3-sector 2012 Chinese SAM is constructed based on the 2007 SAM and various data sources from 2012, updated and balanced using cross-entropy adjustment. The model shows that the trend of labor force reduction with rising wages generates some offsetting forces that favor the increase in per-capita incomes, reduces inequality within a slower growing economy and represents a contributing factor for the rebalancing of the sources of growth.

JEL Classification: O21; O53; C68; Q43.
Keywords: China, Labor Force, Structuralist Macroeconomics, Economic Policy

1 Introduction

In the last 40 years China has been undergoing a process of economic reform that led to rapid industrialization, poverty reduction, increase in labor productivity and an astonishing rate of economic growth. Such reforms are widely regarded as a success although there are now concerns about emerging labor shortages, pre-mature de-industrialization, environmental degradation and extreme income inequality. Policy attention in China has shifted gradually from the goal of rapid growth to the issue of economic and social sustainability as apparent in the 13th Five-Year Plan of the Chinese government.

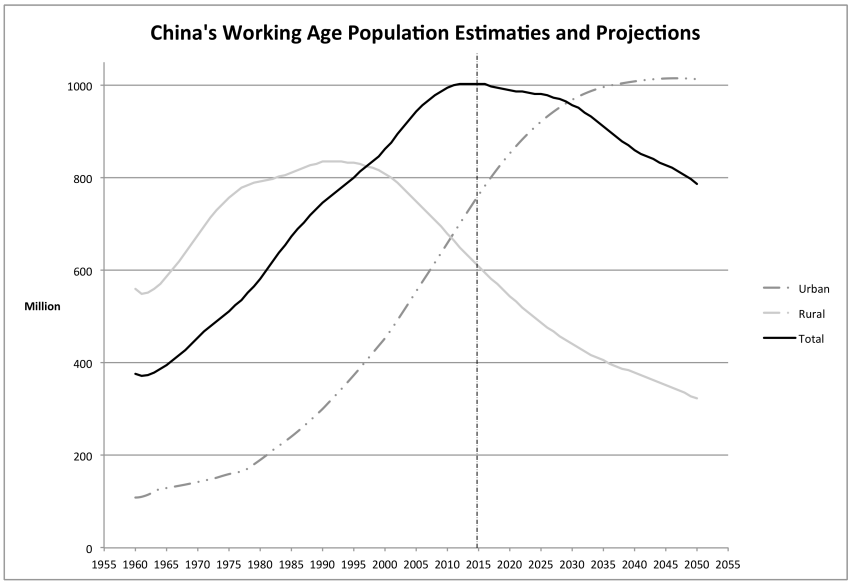
*We would like to thank participants at the 2017 Eastern Economics Association Conference, 2017 International Input-Output Association Conference , 2017 Southern Economics Association Conference , 2019 Regulating Decent Work Conference, and 2020 China Association of Political Economy for comments. The usual caveat applies.

†Senior Economist, International Labor Organization, Geneva, Switzerland. Email: lamarca@ilo.org

‡Trade and Employment Technical Officer, International Labor Organization, Geneva, Switzerland. Email: jiangx@ilo.org. Research Associate, Core China Research, Pamplona, Spain. Associate Professor of Economics, Denison University, Granville, USA.

The Chinese growth model has been often characterized as being "export-led" and "investment-driven" due to the large availability of labor, a low wage environment and the targeted investment policies of the government. Consequently, the sustainability of the Chinese growth model has been increasingly questioned because of the potential effects on wages and international competitiveness of the decline in population and the labor force. Indeed, China introduced the single-child policy in 1979 which, according to some recent demographic studies, was able to contain the population by 400 million by the year 2007. In October 2015, the government relaxed the single-child policy resorting in a two-child policy. In the same year the total labor force started to decline in China, as illustrated in figure 1.

Figure 1: Urban, Rural and Total Working Age Population



Source: World Bank's World Development Indicators

Figure 1 shows the total, the rural and the urban working age population in China (both estimated and projected). Total working age population (dark solid line) started declining in 2015 as the rural working age population had peaked in early 1990s (solid grey line) and the growth rate of urban working population (dashed line) no longer offset the decline in rural areas. Urban working age population is projected to peak around 2040s. The difference between urban and rural population growth rate is also driven by domestic migration from rural to urban areas.[1] The decline of the labor force in China has generated some

[1]The model does not include changes in age structure and labour participation. Therefore, we will not distinguish between the changes in population and in labour force and we will use

anxieties: in absence of other factors such as sustained technological change and direct government interventions, the expected immediate effect of a contraction of the labor force is an "internal appreciation", that is, an upward pressure on wages, which is likely to result in cost-inflation, profit-squeeze and decline in the competitiveness of exports. These are major concerns for an investment-driven and export-oriented developing country. Labor market "flexibility" has become a common recommendation for mitigating negative effects of labor force contraction and containing wage growth (IMF, 2015; Golley and Tyers, 2006; Peng and Mai, 2008). However, labor market flexibility and wage "moderation" while possibly curbing costs and inflation in the short-run can be both socially and economically unsustainable in the long run as they exacerbate inequalities and prevent a rebalancing of the sources of demand from the external sector to the domestic market. This paper investigates whether the reduction of labor force can affect competitiveness and household incomes and if there are mechanisms that can compensate for such effects.

We construct 3-sector model for China to explore the macroeconomic effects of labor force contraction with a minimal amount of sectoral detail. The model is based on a 2012 Social Accounting Matrix for China compiled by the authors. It blends the dual economy approach a' la Lewis (1954) with a structuralist "fix price/flex price" mechanisms in which the service and industrial sectors are demand driven while agriculture is supply constrained and price clearing (Taylor, 1983). Workers in the agricultural sector are assumed to be fully rural, while workers in the industrial and service sector are assumed to be fully urban. We conventionally distinguish between a "short-run" in which migration is possible and macrobalances are satisfied, and a "medium run" in which wages are fully adjusted and labor force can change. In the short run, an increase in demand for industrial and service sectors is accommodated by rural-urban migration at a pre-determined wage rate, drawing from the "surplus labor" in the agricultural (rural) sector, which adjusts without affecting agricultural production. In the medium-run, final and intermediate consumption of agricultural products affect relative prices and generate a cost-push effects in the urban sectors, while wage increases in the industrial and service sectors due to a tightening of the labour market can enhance inflationary pressures and worsen external competitiveness, output demand in the industry and services and reduce migration from rural agricultural activities. "Longer run" effects of capital accumulation and technological change, including increase in agricultural production and productivity, are not included to focus on these specific medium run effects on wages, prices and demand.

It is shown that the negative effect of labor force contraction on output and growth via rising wages has some offsetting effects such as a deflationary effect of the relaxation of the agricultural constraint on prices due to the rural population decline and increased domestic demand effects by wages and agricultural

the two terms interchangeably.

productivity. On the other hand, per capita incomes and consumption can rise more in the rural than in the urban areas reducing the rural/urban income gap. Consequently, labor force contraction and wage increases contribute to the overall patterns of structural transformation and rebalancing of GDP components in China.

This paper has five sections. Section two explains the the structure and compilation of the 2012 Social Accounting Matrix for China. Section three presents the 3-sector model of China. Section four presents and discusses simulation results. Section five concludes with some policy implications and future extensions.

2 China's 2012 Social Accounting Matrix (SAM)

Our 2012 SAM is built by using a 2007 SAM, various data sources and balancing the resulting matrix with the Cross-Entropy (CE) method. Yang and Zhao (2010) constructed the 2007 China SAM based on four data sources: China 2007 Input-Output Tables, China Statistical Yearbook (2008), China Labor Statistical Yearbook (2008) and China Financial Statistical Yearbook (2008). The Macro SAM has more 10 accounts, underlying each account is a double-entry bookkeeping T-account with income on one side and expenditure on the other. The accounting identity ensures that the accounts are balanced, hence the sums and column sums of the SAM are equal. Yang and Zhao (2010) provide a detailed step-by-step description on the construction of SAM. Each accounts is separately compiled by filling most of entries with data from those four aforementioned data sources, then each account is balanced by adjusting the data entry that is either less reliable or relatively less important for modeling.

For 2012 SAM, we used all of the four aforementioned sources of data. However, China's 2012 financial statistical yearbook changed its statistical standards, so that several important flows were missing. We used the cross-entropy balancing method to adjust the missing entries (see Golan et al.,1994, and Robinson et al., 2001).

First, the SAM was adjusted to the China's 2012 input-output table by spitting production and demand into multiple sectors.

Second, current SAM has commodities and activities as separate accounts, which is the standard structure for SAM. To split the SAM as it is into multiple sectors, it will require the availability of China's Supply-Use Tables (SUTs), which is unfortunately not available. What is available instead is a square input-output table with 140 sectors. Thus, to incorporate the square input-output table into the 2012 SAM, we have to first combine the commodities and activities accounts into a single account. And then this account would be split into multiple sectors in accordance with the square I/O table. The only

complication in the "splitting" process lies in how to treat the flow from the commodity account government account. This flow is recorded as the "custom tax" and it is only available as an aggregate. However, if we were to combine the commodities with the activities accounts into a single account, and then split this account into multiple sectors, then we will need by-sector custom taxes, which is unfortunately not available. To resolve the issue, we simply distribute the aggregate custom tax across sectors in accordance with sectoral import shares out of total imports (sectoral import intensities). The "imputed" by-sector custom taxes is then combined with production tax (which is available at sectoral level) as the flow from the combined account to the government.

Third, to facilitate the modeling efforts in the structuralist tradition, we combines the capital account with the firms account, and we combine the labor account with the household account. Essentially, from the structuralist perspective, firms receive profit and households receive wage from engaging in economic activities. (Taylor, 1990, 2011; Von Arnim, 2011) We can also consider firms as "capital-owning households" and households as "wage-earning households". All the consumption comes from households and firms do not consume. If we pay attention to the 2012 China SAM, we would realize that this simplification is does stand on a strong empirical ground. All the labor incomes are directly transferred to the household account, and majority of capital income (or profit) is transferred to the firms account aways.

Forth, since China's 2012 I/O table has by-sector consumptions divided into rural and urban consumptions, we are able to split the household account into rural and urban households. There is a lack of precise information on how household tax (transfer to government account) and saving (transfer to flow of fund account) are divided between urban and rural households, we split these transfers using ratios obtained from external data sources.

Fifth, there is an inventory change account in the SAM which is a passive account in our later modeling exercise. Instead of dropping it, we combined this account with the capital/firms account so the inventory changes are blended in firms' capitals. The final 3-sector 2012 Chinese SAM is exhibited in table 1 below. A more detailed discussion of the SAM will be discussed in the next section.

3 A 3-Sector Model for China

The model has 3 sectors and 3 products: agriculture, industry and services. Agricultural sector is assumed to be fully "rural" and supply-constrained in the short run by arable land and capital. The industry and service sectors are assumed to be fully "urban" and demand-constrained: producers have spare capacity and prices are set as a markup over variable costs. In this simplified 3-sector setting, the economy is "dual" as the rural agricultural sector is charac-

Table 1: 2012 SAM for China

SAM			1. Goods and Services						2. Generation of income		3. Transactions				4. Accumulation	5. RoW Current	Total receipts
			Domestic			Foregin			primary incomes		institutions				Capital and		
			Agriculture	Industry	Services	Agriculture	Industry	Services	Wages	Profits	Rural HH	Urban HH	Firms	Government	Financial		
1. Goods and Services	Domestic	Agriculture	11929.5	45145.2	6132.8						78119.9	12210.5		394.5	5124.1	781.6	89538.1
		Industry	18201.7	456015.0	168181.6						15762.7	52382.7		5.9	48144.3	110457.4	869150.3
		Services	5044.5	114462.4	158419.4						19103.1	80240.5		71799.2	171155.2	25426.8	645723.1
	Foreign	Agriculture	764.3	2863.8	363.8							555.6		11.3	5.0		4563.9
		Industry	1018.9	54105.7	12483.0							7907.0		28.9	15370.2		90913.8
		Services	103.6	4446.1	5074.4							2554.7		942.0	1030.4		14151.3
2. Generation of income	primary incomes	Wages	52996.3	75141.3	135996.5								44777.0	6335.0		5927.0	312173.1
		Profits	2258.2	76285.2	120517.0												199059.9
3. Transactions	institutions	Households							321173.2								3121731.0
		Firms								199060.1							199059.9
		Government	-2778.9	40685.6	38484.2							5820.0	26922.0		77566.0	-387.0	186311.7
4. Accumulation	Capital and Financial										40974.0	75842.0	130978.0	106794.0		-36192.8	318395.2
5. RoW Current						4563.9	90913.8	14151.3					-3617.0				106012.0
Total expenditure			89538.1	869150.3	645723.1	4563.9	90913.8	14151.3	312173.1	199059.9	3121731.0	199059.9	186311.7	186311.7	318395.2	106012.0	

Source: Authors' own compilation

Table 2: The SAM in Symbol with distinction between domestic and imported intermediate inputs

SAM			1. Goods and Services						2. Generation of income		3. Transactions				4. Accumulation	5. RoW Current	Total receipts
			Domestic			Foregin			primary incomes		institutions				Capital and Financial		
			Agriculture	Industry	Services	Agriculture	Industry	Services	Wages	Profits	Rural HH	Urban HH	Firms	Government			
1. Goods and Services	Domestic	Agriculture	$P_1a_{d,1,1}X_1$	$P_1a_{d,1,2}X_2$	$P_1a_{d,1,3}X_3$						$P_1C_{d,1,r}$	$P_1C_{d,1,u}$		$P_1G_{d,1}$	$P_1I_{d,1}$	P_1E_1	P_1X_1
		Industry	$P_2a_{d,2,1}X_1$	$P_2a_{d,2,2}X_2$	$P_2a_{d,2,3}X_3$						$P_2C_{d,2,r}$	$P_2C_{d,2,u}$		$P_2G_{d,2}$	$P_2I_{d,2}$	P_2E_2	P_2X_2
		Services	$P_3a_{d,3,1}X_1$	$P_3a_{d,3,2}X_2$	$P_3a_{d,3,3}X_3$						$P_3C_{d,3,r}$	$P_3C_{d,3,u}$		$P_3G_{d,3}$	$P_3I_{d,3}$	P_3E_3	P_3X_3
	Foreign	Agriculture	$\epsilon P_{f,1}a_{f,1,1}X_1$	$\epsilon P_{f,1}a_{f,1,2}X_2$	$\epsilon P_{f,1}a_{d,1,3}X_3$						$\epsilon P_{f,1}C_{f,1,r}$	$\epsilon P_{f,1}C_{f,1,u}$		$\epsilon P_{f,1}G_{f,1}$	$\epsilon P_{f,1}I_{f,1}$		$\epsilon P_{f,1}M_1$
		Industry	$\epsilon P_{f,2}a_{f,2,1}X_1$	$\epsilon P_{f,2}a_{f,2,2}X_2$	$\epsilon P_{f,2}a_{f,2,3}X_3$						$\epsilon P_{f,2}C_{f,2,r}$	$\epsilon P_{f,2}C_{f,2,u}$		$\epsilon P_{f,2}G_{f,2}$	$\epsilon P_{f,2}I_{f,2}$		$\epsilon P_{f,2}M_2$
		Services	$\epsilon P_{f,3}a_{f,3,1}X_1$	$\epsilon P_{f,3}a_{f,3,2}X_2$	$\epsilon P_{f,3}a_{f,3,3}X_3$						$\epsilon P_{f,3}C_{f,3,r}$	$\epsilon P_{f,3}C_{f,3,u}$		$\epsilon P_{f,3}G_{f,3}$	$\epsilon P_{f,3}I_{f,3}$		$\epsilon P_{f,3}M_3$
2. Generation of income	primary incomes	Wages	w_1L_1	w_2L_2.	w_3L_3								$U_{w,b}$	$U_{w,g}$.		$U_{w,f}$	Y_w
		Profits	Π_1	Π_2	Π_3												Y_b
3. Transactions	institutions	Households							Y_w								Y_w
		Firms								Y_b							Y_b
		Government	T_1	T_2	T_3						T_r	T_u	T_b		$U_{g,k}$	$U_{g,f}$	Y_g
4. Accumulation	Capital and Financial										S_r	S_u	S_b	S_g		S_f	H
5. RoW Current						$\epsilon P_{f,1}M_1$	$\epsilon P_{f,2}M_2$.	$\epsilon P_{f,3}M_3$					$U_{f,b}$	$U_{f,g}$			Y_f
Total expenditure			P_1X_1	P_2X_2	P_3X_3	$\epsilon P_{f,1}M_1$	$\epsilon P_{f,2}M_2$.	$\epsilon P_{f,3}M_3$	Y_w	Y_b	Y_r	Y_u	Y_b	Y_g	H	Y_f	

Source: Authors' own compilation.
Note: For the numerical indices, 1 = Agriculture; 2 = Industry; 3 = Services

terized by surplus labor that can migrate to urban sectors without reducing the level of production in agriculture, while altering its average productivity and rural per-capita incomes. Labor is therefore under-employed in agriculture and can be freely absorbed by the urban sectors at a given wage.[2] The urban wage is given in the short run, but responds to labor market pressures in the medium run: a reduction of the labour force and/or an increase in industry and service demand pushes urban wages up.

The model is based on a 3-sector 2-household group classification illustrated in SAM for China (Table 1). The SAM is a snapshot of the economy at a point in time with rows summarizing incomes and columns summarizing expenditures of each account. Table 2 is the SAM expressed in symbols, which are presented in the current and the following sections.

The production part of the SAM has an input-output structure that distinguishes between imported and domestically produced intermediate inputs: each activity generates only one product and columns (1)-(3) show the production structure of the three sectors "Agriculture", "Industry" and "Services", hereafter. In particular, the intersection of columns (1)-(3) and rows (1)-(6) show the use of the three products as intermediate consumption for domestic production. Demand for imported products are extracted from the uses of intermediate and final consumption using the World Input-Output Database (WIOD) so that uses in the the agricultural, industrial and service sector are split into domestic, denoted by d and and "foreign" products, denoted by f. P_i is the price of product i produced domestically, $P_{f,i}$ is the corresponding foreign price in foreign currency and ϵ is the nominal exchange rate. X_i is the output of sector i, $a_{d,i,j}$ is the intermediate consumption demand coefficient in sector j of domestically produced i while $a_{f,i,j}$ is the intermediate consumption demand coefficient in sector j of the product i that is produced abroad.

The other components of the cost structure of the three activities are found at the intersection of the columns (1)-(3) and rows (7)-(9). The Value added of each sectors is broken down into wages, row (7), and profits, row (8), while taxes on products and import duties, T_i row (9), augment the value of production to obtain output at producers' prices. In particular, rows (7)-(8) are the incomes of workers and enterprises, respectively, with w_j being the wage rate in sector j, L_j its employment level and Π_j the value of profits in that sector. Rows (9)-(10) are the incomes of the government and the rest of the world. Row (11) shows the savings flows of all institutional sectors (households, firms, government) and the rest of the world (RoW).

[2]The data show a level of wage in the urban sector is higher than in rural sector. However wage differential is not the only source of income differences as total income includes also transfers form the government and firms. With overall incomes are higher in the urban than in the rural areas, there has been a general economic advantage of migrating from rural to urban areas which makes urban sectors unconstrained by labor. In the present model income differences are enabling conditions for migration from the rural to the urban sectors and labor demand in urban sectors is ultimately driving the labor allocation between sectors.

The expenditures of the institutional sectors are in columns (7)-(9). The expenditures for capital formation (investment demand) and of the rest of the world (exports and incoming transfers) are in columns (10)-(11). In particular, the intersection of rows (1)-(6) and columns (7a) and (7b) are the final consumption expenditure of rural households r on product i produced domestically d, $C_{d,i,r}$, the expenditure of urban households u on product i produced domestically d, $C_{d,i,u}$, and the consumption of urban households u on product i produced abroad f, $C_{f,i,u}$. The entries in the sub-matrix of columns and rows (7)-(10) are payment flows among households and other institutional sectors and the rest of the world. More specifically, $U_{w,b}$, $U_{w,g}$, and $U_{w,f}$ are the transfers from firms, government, and rest of the world to households, T_r, T_u,T_b and are income taxes from rural, urban households and firms, $U_{g,f}$ are income flows from the rest of the world to the government and $U_{g,k}$ to the government. Column and row (11) represent the Flow of Funds account which shows the resulting saving and investment balance: S_r, S_u, S_b, S_g and S_f are rural, urban households, firms, government and foreign savings financing aggregate investment and demand of domestic $I_{d,i}$ and foreign capital goods $I_{f,i}$. Finally, Y_r, Y_u, Y_b, Y_g and Y_f are the total incomes and uses of rural, urban households, firms, government and RoW.

3.1 Sectoral Demand and Production

The material balance of the three products, both domestic and imported, is given in equations (1)-(2) which correspond to the sums of the elements of rows (1)-(6) in Table 2.

$$X_i = \sum_j a_{d,i,j} X_j + C_{d,i,r} + C_{d,i,u} + G_{d,i} + I_{d,i} + E_i \tag{1}$$

$$M_i = \sum_j a_{f,i,j} X_j + C_{f,i,u} + G_{f,i} + I_{f,i} \tag{2}$$

with $j \in \{Agr, Ind, Ser\}$ indicating the activities using intermediate consumption and for all products $i \in \{Agr, Ind, Ser\}$. The technique of production is given in the short run and coefficients are fixed. As we do not investigate technical change and effects of investment on productivity we assume the coefficients are fixed also in the medium run.

Exports are conventionally modeled using a constant elasticities export function:

$$E_i = \chi_{o,i} \left(\frac{\epsilon P_{f,i}}{P_i} \right)^{\chi_{p,i}} (X_f)^{\chi_{f,i}} \tag{3}$$

for all products $i \in \{Agr, Ind, Ser\}$ and with $\chi_{o,i}$,$\chi_{p,i}$, and $\chi_{f,i}$ constant parameters, ϵ the nominal exchange rate, defined as units of local currency per unit

of foreign currency, and X_f an exogenously given level of foreign demand. This specification allow "competitiveness" to depend on the relative price of foreign, $\epsilon P_{f,i}$, and domestic products, P_i, and to drive export demand together with global demand expansion.

Domestically produced intermediate consumption products can be substituted with the corresponding imported products according to the CES function:

$$a_{i,j} = \left(\alpha_{i,j}{}^{\frac{1}{\sigma_{i,j}}} a_{d,i,j}{}^{\frac{(\sigma_{i,j})-1}{\sigma_{i,j}}} + (1-\alpha_{i,j})^{\frac{1}{\sigma_{i,j}}} a_{f,i,j}{}^{\frac{(\sigma_{i,j})-1}{\sigma_{i,j}}} \right)^{\frac{\sigma_{i,j}}{(\sigma_{i,j})-1}} \tag{4}$$

for $i \in \{Agr, Ind, Ser\}$ and for $j \in \{Agr, Ind, Ser\}$.

The underlying assumption is that imported and domestically produced goods are similar enough to be imperfect substitute while performing the same function in the given production technique. The total cost of the intermediate consumption of product i per unit of activity j is:

$$P_{\text{int},i,j} a_{i,j} = P_i a_{d,i,j} + \epsilon P_{f,i} a_{f,i,j}. \tag{5}$$

A change in the domestic/foreign composition of intermediate consumption does not alter the aggregate intermediate consumption requirement $a_{i,j}$ which is given. Parameters $\alpha_{i,j}$ and $\sigma_{i,j}$ are the share factor and elasticity of substitution between domestic and imported inputs, respectively.

The price of the aggregate intermediate consumption $P_{\text{int},i,j}$ is an harmonic average of the domestic price, P_i, and foreign price, $\epsilon P_{f,i}$, derived by the cost minimizing choice of $a_{d,i,j}$ and $a_{f,i,j}$:

$$P_{\text{int},i,j} = \left(\alpha_{i,j} P_i{}^{(1-\sigma_{i,j})} + (1-\alpha_{i,j}) \epsilon P_{f,i}{}^{(1-\sigma_{i,j})} \right)^{\frac{1}{1-\sigma_{i,j}}} \tag{6}$$

Similarly, the demand functions of $a_{d,i,j}$ and $a_{f,i,j}$ in (7)-(8) are obtained from (4) and are functions of the ratio between their own price and the aggregate intermediate consumption price for the same product:

$$\frac{a_{d,i,j}}{a_{i,j}} = \alpha_{i,j} \left(\frac{P_i}{P_{\text{int},i,j}} \right)^{-\sigma_{i,j}}. \tag{7}$$

$$\frac{a_{f,i,j}}{a_{i,j}} = (1-\alpha_{i,j}) \left(\frac{\epsilon P_{f,i}}{P_{\text{int},i,j}} \right)^{-\sigma_{i,j}}. \tag{8}$$

As only 3 of the 5 equations (4)-(8) are independent, we can choose (6)-(8) for simplicity. The column sums of columns (1)-(3) in table 2 give the cost decomposition of production in the three sectors. Using (5) and dividing by X_j, we obtain:

$$P_j = \sum_{i=1}^{3} (P_{\text{int},i,j} a_{i,j}) + \frac{w_j}{\xi_j} + P_j \pi_j + P_j t_j \tag{9}$$

where

$$\xi_j = \frac{X_j}{L_j}, \tag{10}$$

$P_j\pi_j = \Pi_j/X_j$ is the value of profits and $P_j t_j = T_j/X_j$ is the value of sales taxes and import duties per unit of product, and $j \in \{Agr, Ind, Ser\}$.

The industrial and service sector have spare capacity utilization and output adjust to demand which is driven by price and re-distributional effects. We assume constant labor productivity in the industrial and service sector, ξ_{Ind} and ξ_{Ser}, given by a fixed production technique, so that equation (10) determines employment for any level of output. The price decomposition, equation (9), shows that intermediate consumption, wages, profits and indirect taxes add up to the unitary value of the product. Industry and service sector output adjusts to demand with no supply constraint in the short run and prices are determined according to a fixed markup over variable costs (intermediate consumption, wages and taxes). This results in a constant profit share of gross output. Equations (5) and (9) show how exchange rate and domestic price changes can affect the cost of intermediates and push final product prices. In particular equation (9) represents a cost-side price determination mechanism which depends on intermediate product prices, wages, profits and taxes. With a fixed profit share, π_j, and tax rate, t_j and for a given money wage, w_j , in the short run, product prices respond to intermediate consumption prices and wage increases passing through them according to production coefficients. On the other hand, the agricultural sector is capacity constrained and has fixed output $\tilde{X}_{Agr}$ for the level of product demand, technology and labor supply relevant for this analysis. Under this regime (10) determines a varying average productivity and agricultural prices adjust to clear the product market. With prices determined to adjust demand (consumption, investment, exports less imports) to a given supply, and with productivity determined by labor availability and (10), then equation (9) can only determine agricultural wages as a residual.[3]

Total labor force is given in the short run and allocated endogenously to the three sectors

$$LF = L_{Agr} + L_{Ind} + L_{Ser}. \tag{11}$$

This specification excludes open unemployment but lets the agricultural sector being a sink for underemployment.[4]

[3]Some limited substitutability between domestic and imported intermediate consumption goods can limit but not offset the cost-push effects of intermediate products on output prices.

[4]This form of duality that associates "traditional" and less productive activities with a specific branch of the economy such as agriculture and the rural area. This is a clear simplification of the most complex case where "traditional" and more "modern" and productive activities coexist in the same branch of production such as in the case of having "traditional" vs. "modern" services.

3.2 Institutional sectors

We define total household income

$$Y_w = \sum_j L_j w_j + U_{w,b} + U_{w,g} + U_{w,f} \tag{12}$$

with $j \in \{Agr, Ind, Ser\}$.

Household income is used for final consumption, savings and paying income taxes:

$$Y_w = \sum_i \left(C_{d,i,r} P_i + C_{d,i,u} P_i + C_{f,i,u} \epsilon P_{f,i}\right) + (T_r + T_u) + (S_r + S_u) \tag{13}$$

with $i \in \{Agr, Ind, Ser\}$. While we have expenditure by rural and urban household (13), we have only the total revenue to all the households (12). We define δ as the urban household share of total household income. Transfers between households, government and rest of the world, denoted by $U_{i,j}$, are treated exogenously in nominal terms unless otherwise specified.

$$\delta = \frac{\left(\frac{L_{Ind}+L_{Ser}}{LF} + \gamma\right)\left(U_{w,b} + U_{w,g} + U_{w,f}\right) + L_{Ind} w_{Ind} + L_{Ser} w_{Ser}}{Y_w} \tag{14}$$

The share of total revenues depends on the allocation of labor in the three sectors and the share of transfers to household from firms, government and the rest of the world.[5] A parameter γ allows for a larger share of transfers to urban households beyond their share in the total employment. This can be motivated on the basis of the income transfers from the government and property income which is more likely to accrue to urban households.[6]

is then broken down into rural and urban and the uses of income for consumption, tax payments and savings become, respectively,

$$(1 - \delta) Y_w = \Gamma_r + T_r + S_r \tag{15}$$

for rural and

$$\delta Y_w = \Gamma_u + T_u + S_u \tag{16}$$

for urban households.

[5] While the information on the consumption of rural and urban households were available in the Input Output table for China, a distinction between rural and urban households incomes is assumed based on sectoral wages and employment.

[6] In this simplified context, we assume that the relative shares of labor in rural and urban sectors are a proxies of population shares.

We define t_r and t_u the income tax rates of rural and urban households, respectively

$$T_r = (1-\delta)Y_w t_r \tag{17}$$

$$T_u = \delta Y_w t_u \tag{18}$$

and total consumption of rural and urban households, Γ_r and Γ_u, as follows:

$$\Gamma_r = (1-\delta)Y_w\left(1-s_r\right)\left(1-t_r\right). \tag{19}$$

$$\Gamma_u = \delta Y_w\left(1-s_u\right)\left(1-t_u\right) \tag{20}$$

Therefore, savings are a given fraction s_r and s_u of disposable (after tax) income of each household groups.

$$S_r = s_r(1-\delta)(1-t_r)Y_w. \tag{21}$$

$$S_u = s_u\delta(1-t_u)Y_w. \tag{22}$$

Definition (14) and equations (15)-(22) sum up to the revenue-expenditure constraint (12)-(13).
Consumption is modeled as a Linear Expenditure System (LES) as below:

$$P_i C_{d,i,r} = P_i\Theta_i^r + \mu_i^r\left(\Gamma_r - \sum_j P_j\ \Theta_j^r\right). \tag{23}$$

$$P_i C_{d,i,u} = P_i\Theta_i^u + \mu_{d,i}^u\left(\Gamma_u - \sum_j P_j\ \Theta_j^u\right) \tag{24}$$

$$\epsilon P_{f,i} C_{f,i,u} = \mu_{f,i}^u\left(\Gamma_u - \sum_j P_j\ \Theta_j^u\right) \tag{25}$$

with $\sum_i \mu_i^r = 1$ and $\sum_i \mu_{d,i}^u + \sum_i \mu_{f,i}^u = 1$ for i and $j \in \{Agr, Ind, Ser\}$. Following the SAM data, rural consumption is made of domestic products only, (23), while urban households consume both domestic and imported products, (24)-(25). However, only domestic products are used in the minimum consumption basket, with the levels Θ_j^u, hence the differences between (24) and (25).

Firms balance

$$\sum_j \Pi_j = U_{w,b} + U_{f,b} + T_b + S_b \tag{26}$$

can be expressed as the sum of tax and distributed profit of state owned enterprises (SOE) T_b

$$T_b = \sum_j \Pi_j t_b \tag{27}$$

distributed profits to domestic households, U_{hb}, and retained earnings, S_b:

$$U_{w,b} = (1 - s_b) \left((1 - t_b) \sum_j \Pi_j - U_{f,b} \right) \tag{28}$$

$$S_b = s_b \left((1 - t_b) \sum_j \Pi_j - U_{f,b} \right) \tag{29}$$

where the retained earnings are a fraction s_b of the disposable income after profit taxes, SOE dividends and foreign interests income have been paid.

The government balance between revenues and expenditure

$$\sum_i T_i + T_r + T_u + T_b + U_{g,f} + U_{g,k} = \sum_i (P_i G_i + \epsilon P_{f,i} G_{f,i}) + U_{w,g} + U_{f,g} + S_g. \tag{30}$$

obtains the government fiscal balance, S_g, as the residual.

We consider government transfer to households, $U_{w,g}$, depending inversely on their consumption level according to two parameters g_w and ψ and the function

$$U_{w,g} = g_w \left(\Gamma_r + \Gamma_u \right)^{-\psi} \tag{31}$$

Foreign savings S_f(the current account deficit) is

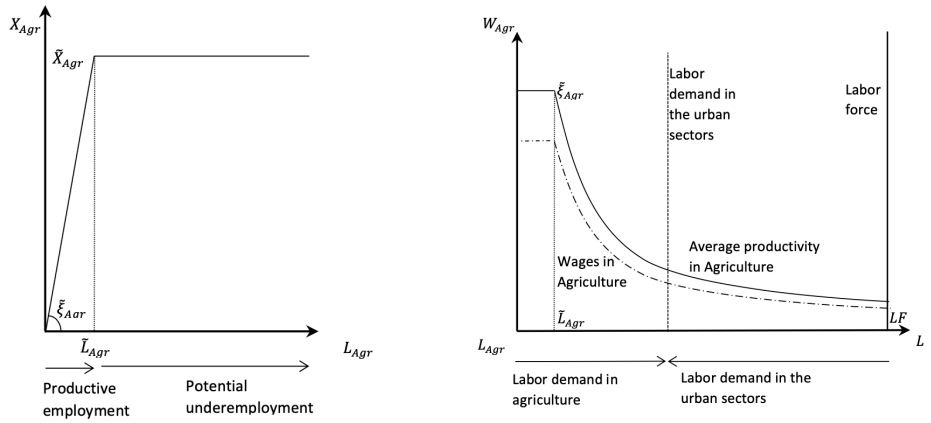
$$S_f = \epsilon \sum_i P_{f,i} M_i + U_{f,b} + U_{f,g} - \sum_i P_i E_i - U_{w,f} - U_{g,f}. \tag{32}$$

3.3 Agricultural labor productivity, urban wages and rural urban migration

Agricultural production is constrained by land and capital availability and their productivity in the short and medium run. When this capacity constraint binds, say at $\tilde{X}_{Agr}$, labor is underemployed in the sense that a reduction of labor input in agriculture does not reduce output. With no technical change and a potentially binding capacity constraint, there are two regimes: (i) a constant productivity regime up to the maximum level $\tilde{X}_{Agr}$, in which labor is productively employed up to the level $\tilde{L}_{Agr}$, and (ii) a surplus labor regime in which

Figure 2: Relation between agricultural productivity, wages and labor demand in rural and urban sectors

(a) Output and Employment in Agriculture (b) Agricultural productivity and wages and labor demand



$\tilde{X}_{Agr}$ is reached and additional labor employed reduces total average productivity $\tilde{\xi}_{Agr}$ (Figure 1).

Figure 2a shows agricultural product and employment in the two regimes, the maximum productivity $\tilde{\xi}_{Agr}$ and level of labor $\tilde{L}_{Agr}$ that can be productively employed. Under this regime further increases in labor input in agriculture do not increase output as product is constrained by capital and land availability. Figure 2b shows how product per worker is constant and equal to $\tilde{\xi}_{Agr}$ up to $\tilde{L}_{Agr}$ before declining. This generates underemployment in the agriculture and a surplus labor that can be employed in the urban sector at no cost in terms of agricultural production. The product per worker of agriculture is distributed to intermediate consumption, taxes on products and value added which is composed of wages and profits. The distinction between wages and profits in agriculture is often conventional, since much of the incomes accrues in mixed forms. We assume that the profit share is constant and that wages are set as difference between value added and profits, with value added being determined by total production minus the value of taxes and intermediate consumption. The latter is a function of relative prices. The dashed dotted line in panel 2b represents one of the possible shapes of the wage and profit incomes in agriculture in relation to productivity. The figure shows how labor demand in the urban sectors (dotted line) and a fixed labor force in the short run LF determine whether the system is in a regime of fixed agricultural productivity or of surplus labor. The latter is the regime relevant for the present analysis. Technical changes and large changes in population in the longer run can gen-

erate an endogenous regime switch leading to a "full productive employment" state in agriculture with no labor surplus. This is a form of Lewis "turning point" in which the system ceases to be dual.

Employment in agriculture is therefore composed of a productive $\tilde{L}_{Agr}$ and a surplus L_s components

$$L_{Agr} = \tilde{L}_{Agr} + L_s \tag{33}$$

with

$$\tilde{L}_{Agr} = \frac{\tilde{X}_{Agr}}{\tilde{\xi}_{Agr}}. \tag{34}$$

Nominal wages in industrial and service sectors are exogenously given in the short run, but it are updated recursively in the medium term. A possible wage curve determining wages at time $t+1$ given employment and prices at time t has the form

$$w_j[t+1] = P_j[t]\frac{k_j}{1-\frac{L_j[t]}{LF[t]}} + w_{\min,j}, \tag{35}$$

where k_j is a bargaining power parameter, $w_{\min,j}$ a minimum wage and the sectoral employment relative to the labor force, $L_j[t]/LF[t]$, is a measure of the labor market tightness.

Equation (35) completes the "static" system (1)-(33) in the medium run determining the 78 variables, which can all be considered as referring to the same time t as well as W_{Ind} and W_{Ser} which refer to time $t+1$. Depending on the parameter values the model may or may not converge to a dynamic equilibrium either asymptotically or with a "cobweb type" dynamics between sectoral employment, and other aggregates, and wages.

Figure 3a shows the wage curve and the employment and wage determination by the demand in the product market in the industry and service sectors (vertical dashed line).[7] Figure 3b is the composition of figure 3a and the mirror image of figure 2b to show how fixed labor force, labor demand determination in the urban sectors determine wages in the urban sectors and productivity and wages in the agricultural sector.[8]

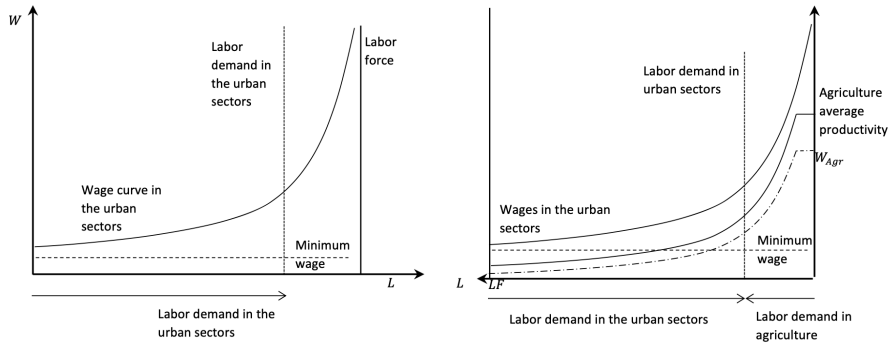
Population and labor force changes can be modeled using a logistic function of the kind

[7] More precisely, there are a wage curve for industry and one for service that can be aggregated "horizontally", that is, it is possible to obtain and sum the demand of labor in the two sectors for each level of wage, yielding figure 3a.

[8] A wage differential between urban and rural sectors will persist as long as the wage curve of equation (35) is higher than the wage productivity or the wages in agriculture. This will depend on the determinants of the wage curve including minimum wages and technology and resource constraints in agriculture determining $\tilde{\xi}_{Agr}$ and $\tilde{X}_{Agr}$.

Figure 3: Wage determination and sectoral labor demand

(a) Wage and employment in urban sectors (b) Sectoral labor demand and wages



$$\frac{\mathrm{d}LF[t]}{\mathrm{d}t} = g_p LF[t]\left(1 - \frac{LF[t]}{LF^*}\right) \tag{36}$$

where g_p is a growth rate and LF^* is the final level of LF in the medium run. Equation (36) is added both for convenience and realism as population jumps or indefinite exponential growth (or contraction) of the LF, which would correspond to a $LF^* \to \infty$, are implausible. It adds the dynamics of LF which remains independent and therefore exogenous to the rest of the system.

The model does not explicitly treat capital accumulation and technological change and comparative dynamics can be considered as departing from a stationary state in which agriculture output and other sectors production grow with capital accumulation and investment demand. Therefore, simulation of shocks should be intended as deviations from such as steady state (i.e. additional investment demand or negative contribution to population growth).

The model features a system of 81 equations, and they are calibrated based on the 2012 Chinese SAM, China Statistical Yearbook (2013), China Labor Statistical Yearbook (2013), Imb and Mejean (2010) (for trade elasticities) and Willenbockel (2006) (for Frisch parameter).

4 Simulation Results

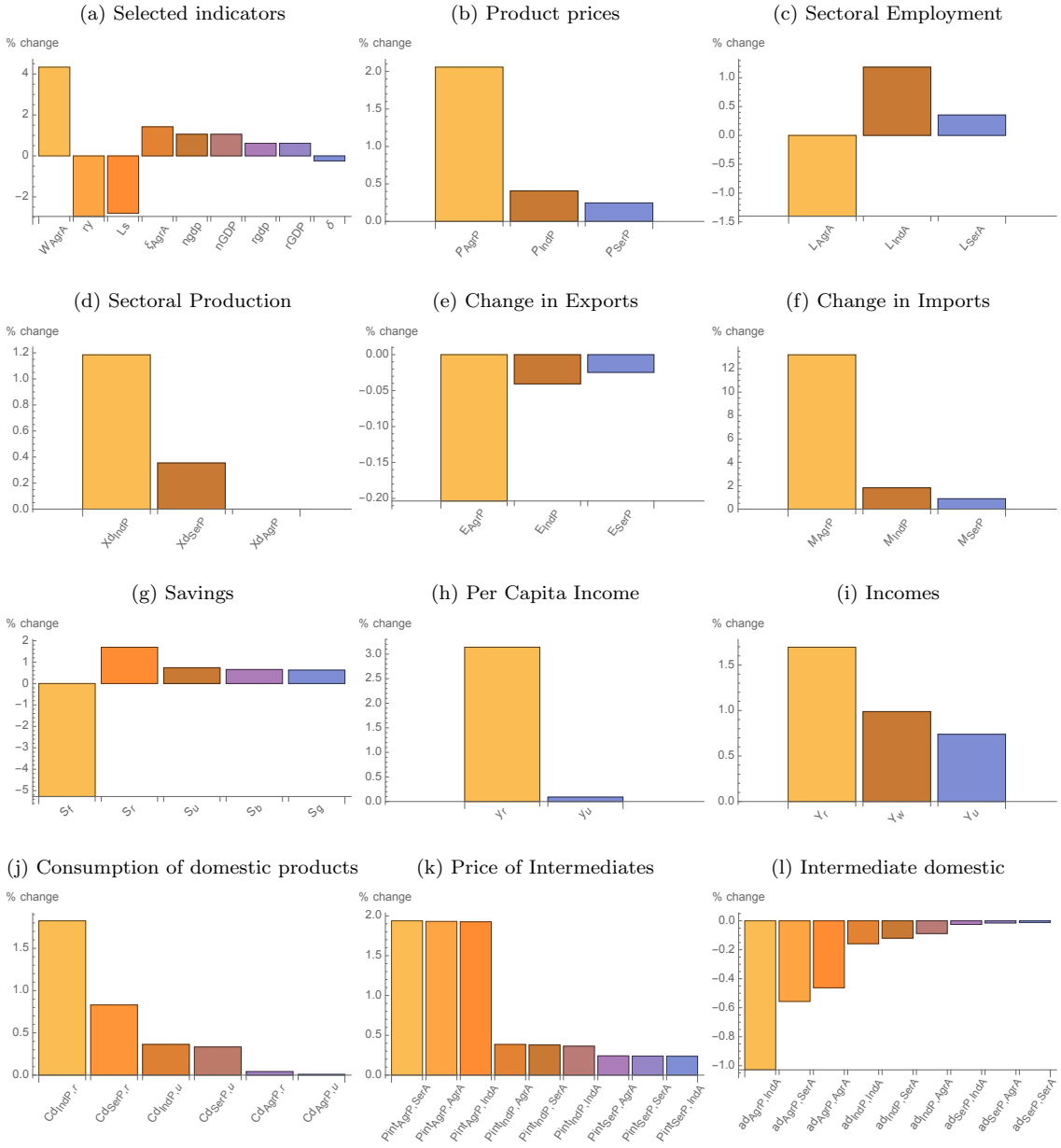
We show the characteristics of the model with some indicative changes affecting aggregate demand, competitiveness and labor supply. We assume that in the short-run wages in the urban sectors are not adjusting to labor market conditions and we observe the overall impacts of a (i) investment demand increase in the industrial sector, (ii) an exogenous wage increase in the urban sectors and

(iii) labor force contraction in the static model. We then observe how endogenous wage adjustment affects the results of a labor force contraction in the full dynamic model.

4.1 Short-Run Static Simulation

We observe first the effects of 10% industrial investment demand increase on the static system. This is a typical demand shock similar to other demand components exogenous changes such as public expenditure or exports induced by increased world demand. These were typical sources of growth for China embodying the paradigm of export and investment-driven economy (Figure 4).

Figure 4: Selected Effects of 10% Industrial Investment Demand Increase



The simulation results are to a large extent consistent with China's experience of growth and structural transformation. Real and nominal GDP in absolute and per capita terms, $rGDP$, $nGDP$, $rgdp$ and $ngdp$, respectively,

increase. Labor surplus L_s decreases as labor moves to urban sectors (panels 4a and 4b). Productivity and wages in agriculture increase (panel 4a) raising both the absolute and per capita incomes for both the rural and urban households (panels 4i and 4h). Production in the industry and service sector increases (panel 4d) in spite of some price increases in the agricultural output generated by increased demand over the fixed production constraint (panel 4b). These price increases pass-through to the industry and services (panel 4b) affecting competitiveness, reducing exports and increasing imports (panels 4e and 4f). Price pass-through via intermediate consumption price (panel 4k) is partly reduced by the substitution in intermediate consumption (panels 4l).

Investment-driven output growth results economy-wide inflation due to the supply constraint of agriculture and cost-push effect on the other sectors via intermediate inputs. Growth in industrial and service sectors generate high agricultural demand that adjusts to the fixed supply via price increase and reduction in agricultural exports and final consumption. Although this is an extreme example of agricultural price adjustment, the steady raising food price accompanied with China's structural change has been a major concern for the Chinese government especially since the 2000s. (Zhang and Law, 2010)

The rural-urban migration is associated with falling agricultural and raising industrial and service employment: a typical result of structural change. With domestic prices increasing relative to the foreign prices, Chinese goods and services become less competitive in the world market and exports contracts in all sectors. The decline is particularly large in agricultural sector due to more rapid inflation and in the industrial sector given its export intensity. The slowing down of Chinese exports is a noticeable phenomenon since the last 2000s and China has became a net importer of agricultural goods since 2004 and is now a major market for world agricultural exports. (Gale et al., 2015; Carter and Steinbach, 2013)

Final consumption is broken down into rural and urban household consumption and by product, with urban households consuming domestic and foreign products. Investment-driven industrialization results higher income and consumption for urban households as expected, and we observe households substituting domestic consumption with foreign imports.

While absorbing surplus labor from agriculture and increasing its productivity and increasing incomes in rural areas, this growth scenario generates a price effects and pressures on the trade balance that require avoiding other sources of price pressure such as wage increases. Incomes in urban areas increase with larger availability of jobs, but the "average income" stagnates. "Wage moderation" can be called for as a solution to maintain competitiveness and preserve this growth paradigm.

As it will be shown below endogenous wage increases can be the result of

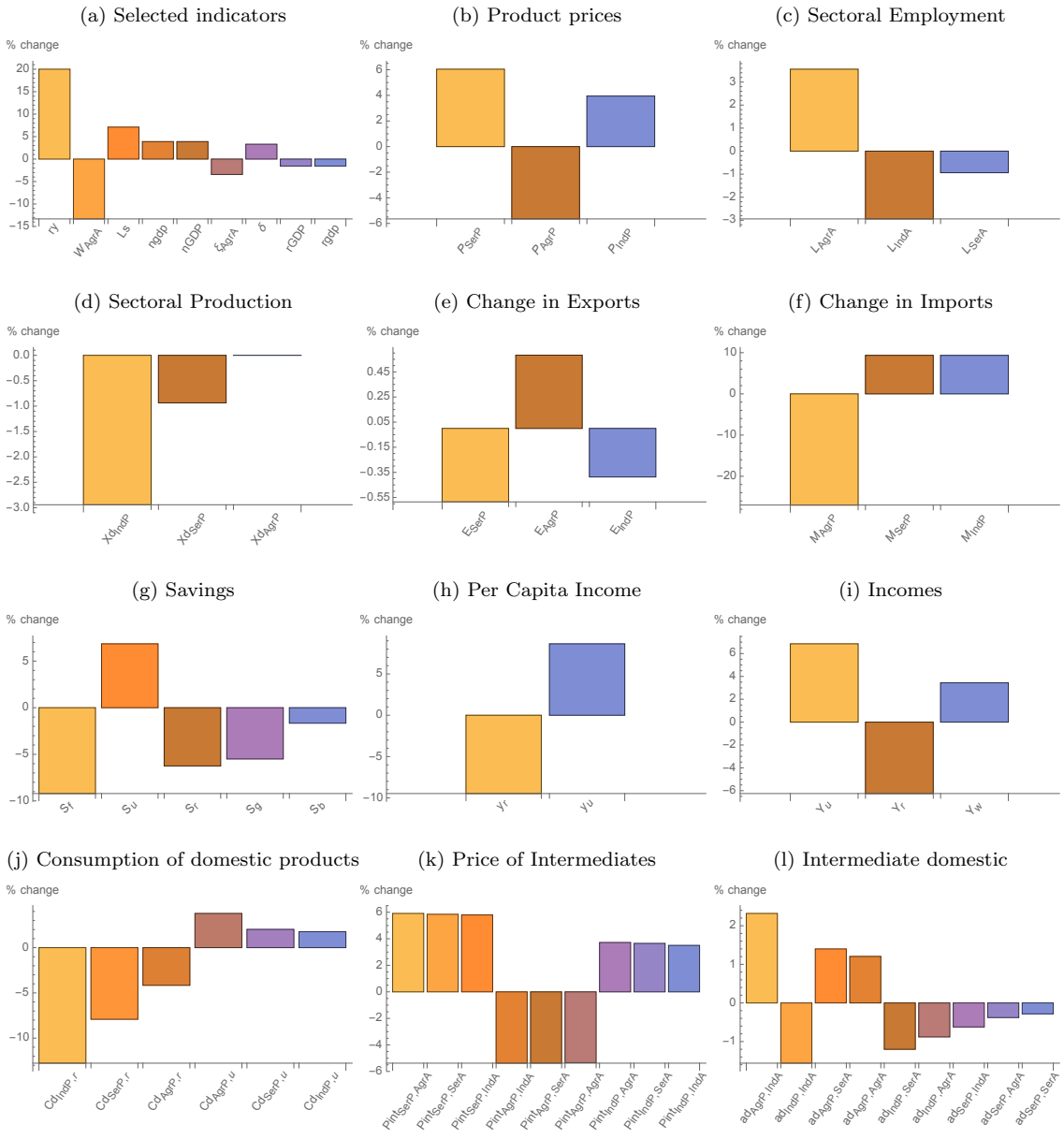
labor force contraction. The anxiety of wage increase as one of the possible results of labor force contraction can be illustrated by the second exercise which isolates a 10% industrial wage increase. The simulation results are shown in figure 5. In absence of other effects, a wage increase in the industry and service sector alone will result in price inflation in both industrial and service sectors as expected (panels 5b). Price inflation creates a slight fall of real consumption and relatively large fall of exports and increase of imports of industrial goods and services (panels 5j, 5d,5e). Given the export dependence of the Chinese economy, we can expect contraction in outputs (panel 5d). Economic contraction results in lower demand for agricultural products, both as final consumption and intermediate input goods. Henceforth reduces the agricultural price (panel 5b), which also gives a slight boost for agricultural exports.

On the employment side, a contraction of urban sectors generates more surplus labor with unemployed workers moving from industrial and service sectors to the agricultural sector. This result is due to the oversimplifying assumption the agricultural sector is the only absorber of underemployment. More realistic assumptions of having informal and less productive manufacturing and service sectors will not change the result of decreasing average productivity and incomes in the shock absorbing sectors.

Industrial and service sector wage increase triggers nominal consumption increase from urban households on both domestically and foreign produced goods. However, agricultural household nominal consumption on industrial and service goods falls due inflation with stagnating wage, but their nominal consumption on agricultural goods increases thanks to the fall of agricultural price. Intermediate consumption of domestic agricultural goods increases while intermediate consumption of industrial goods and services decline due to price substitution.

What has been illustrated here is a popular rationale behind the concerns over industrial wage increase in China. Essentially, the fear is that urban wage increase would generate inflation, unemployment, and exports contraction so that the overall economic growth will be jeopardized.

Figure 5: Selected Effects of 10% Urban Wage Increase

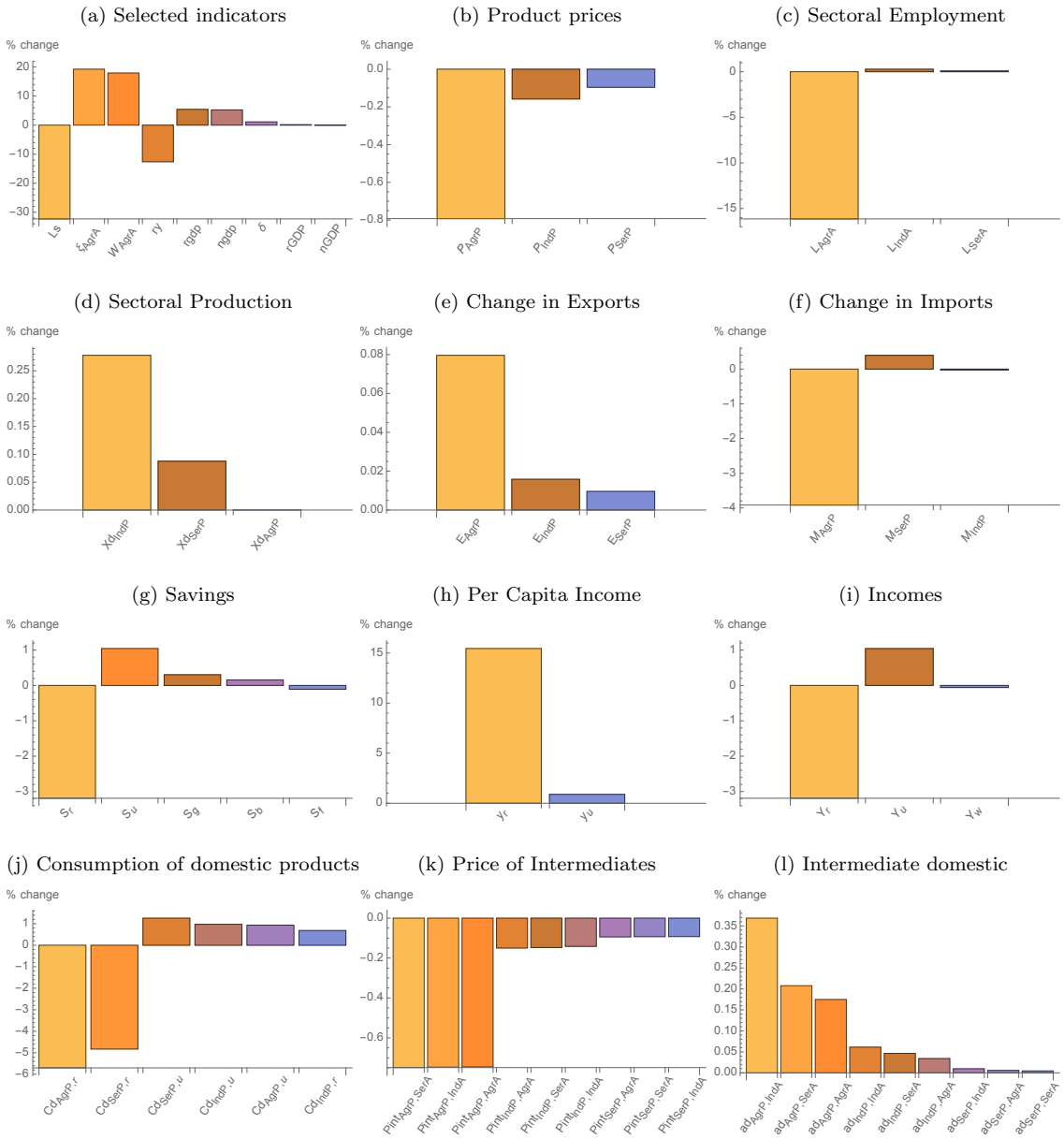


We isolate now the effects of a 5% labor force contraction and observe the results assuming that urban wages are fixed (figure 6). Labor force contraction alone is slightly expansionary as it increases the product per capita in agriculture and increases rural per capita incomes in a rather *Malthusian* fashion (panel

6a and (panel 6h)). The immediate effect of population contraction is the fall of demand for agricultural (food) products (panel 8j), mostly because population and labor force falls in rural areas (panel 6c) and because agricultural goods represent a larger share in the consumption basket of rural households than urban households. With a given production in the agricultural sector, the fall of agricultural demand immediately reduces agricultural price (panel 6b), and the fall of agricultural prices also leads to slight fall of industrial and service prices reducing intermediate input prices and tilting demand towards domestic products (panels 6k, 6l, 6e and 6f). Price and external balances effects remain limited. Total incomes in rural areas and consumption fall (panels 6i and 8j) with an increase of per capita incomes (panels 6h) and a reduction of the rural-urban gap (ry in panel 6a)

The expansion in industrial and service sector combined with lower prices also generate higher real income for urban households, hence we can observe that the increase of urban consumption on both domestic and foreign goods. In general a reduction in the labor force reduces the underemployment and the tightness of the agricultural constraint, but it has small effects on output and urban incomes assuming a fix wage in urban sectors.

Figure 6: Selected Effects of 5% Labor Force decrease



4.2 Medium-run dynamic effects

An endogenous wage adjustment according to equation 35 can be used to observe the composition of the effects of wage increases and labor force reduction

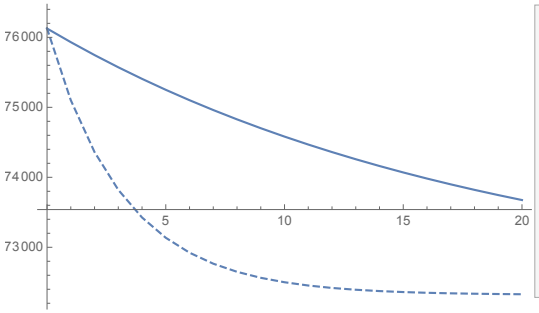
over time. Equation 35 and figures 3a and 3b show how labor force contraction can reduce the surplus labor and increase urban wages for any given level of output and labor demand in the services and industrial sectors. The dynamics of the labor force follows equation 36, a logistic function where the "carrying capacity" LF^* is set to 95% of the original LF level. The parameter configuration of the labor demand and wage curve generate an asymptotic convergence to the medium run equilibrium of full wage and population adjustment.

Figure 7 show this dynamic path over 20 years. Solid lines denote a slower while dashed lines and faster adjustment rate of the labor force to its final 5% decrease. The final equilibrium is a combination of the previous labor force and wage shocks. The reduction of labor surplus in agriculture increase average productivity, wages and per capita incomes in the rural areas, while the increase in wages in urban sectors increases. GDP both in current and constant prices is almost left unchanged while GDP and incomes per capital increase. Wages pass-through prices but are partly offset by the reduction of agricultural prices induced by lower population pressure.

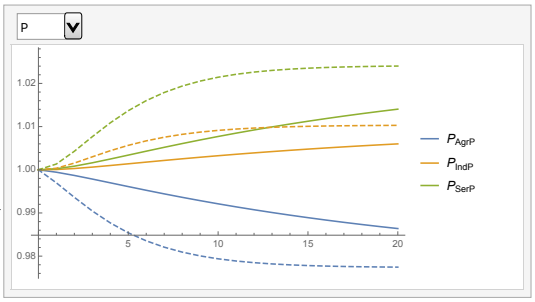
Prices are quite stable in this case as illustrated in panel 7b. This is because the upward pressure on price generated by wage increase is counteracted by the downward pressure on prices generated by the loosing up of the agricultural constraint. Modest reduction of industrial and service production and worsening of external competitiveness are more than compensated by the wage increase generating net gains in urban areas. Finally the rural-urban per capita income gap is improved by the larger growth of rural incomes. The composition of the effects on prices, demand and employment in this medium term scenario show a process of dynamic rebalancing in which slower GDP growth coexists with increasing per capita incomes in both rural and urban areas and reduction of their inequality.

Figure 7: Medium-run Effects of 5% Labor Force decrease

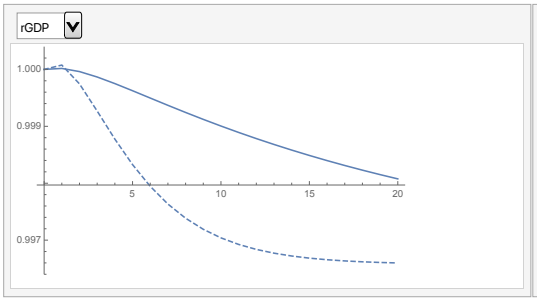
(a) Labor Force



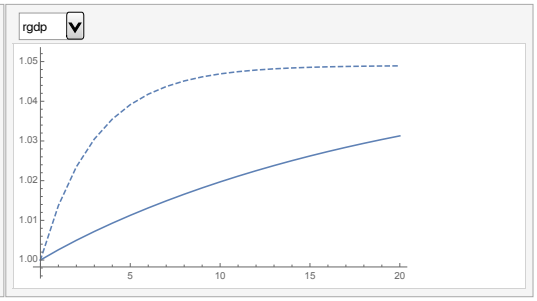
(b) Product prices



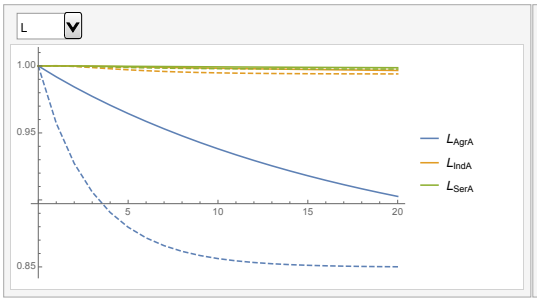
(c) GDP constant prices



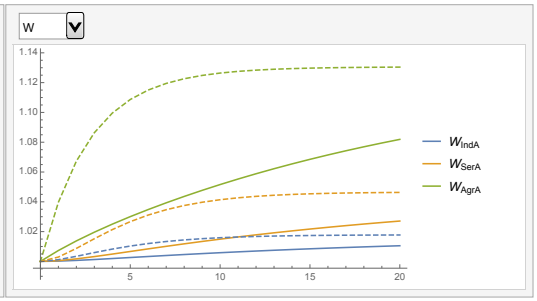
(d) per capita GDP constant prices



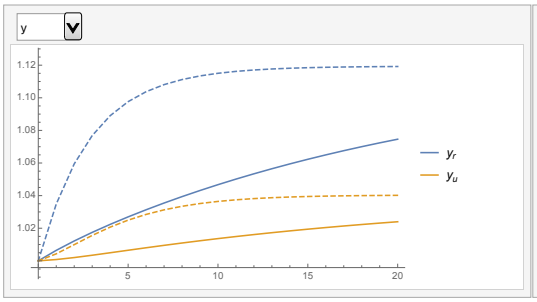
(e) Sectoral Employment



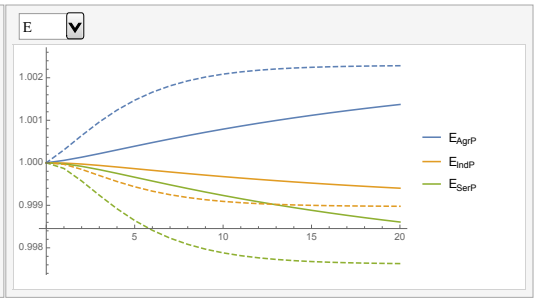
(f) Sectoral Wages



(g) Change in per Capita Incomes



(h) Change in Exports



5 Conclusions

China growth paradigm has been characterized by export and investment-driven product demand and the availability of low wage labor in a context of sizable labor force and rural-urban migration. The recent trend of population, labor force contraction and increasing wages has raised concerns that growth and prosperity can be chocked off by a loss of international competitiveness. Recent persistent trends of declining global growth and international demand of tradable products have also questioned an heavy reliance on a pure export-led model. Indeed, China is already undergoing a process of rebalancing of sources of growth leading to less availability of low wage labor and more reliance on domestic demand of products.

This paper uses a structural simulation model with a comparative static and dynamic component that generates many factual aspects of China's emerging trends framing them in a dual economy context in which surplus labor is generated by pace of relative change of the economy's binding "resource constraint", i.e. agriculture, and population growth.[9] The present analysis exclude technical change, it pins down the agricultural constraint by assuming fixed output and lets population change. The interplay of the resource constraint and population generate the surplus labor that can be freely employed in the "modern" (more productive) sectors.

While availability of low wage labor can generate employment and growth in an investment and export driven context, it can become a source of stagnant incomes when external circumstances change. It is shown that the trend of labor force reduction with rising wages generates some compensating forces that favor the increase in per-capita incomes, reduces inequality within a slower growing economy and represents a contributing factor for the rebalancing of the sources of growth. The Lewis' switching point takes here the form of reduction of surplus labor by reducing labor force growth and an overall wage increase: a scenario that does not imply stagnating per capita incomes, but can rather lead to a more balanced growth pattern.

[9] The "resource constraint" is here some factor limiting agriculture but could be any natural or environmental constraint affecting some other sectors or the entire production system in general.

References

[1] C. Carter and S. Steinbach. China's growing role in agricultural trade. *ARE Update*, 17(1), Sep./Oct. 2013.

[2] J. Fan, Z. Yang, and D. Zhao. The construction of china macro social accounting matrix. *World Economic Papers*, 4, 2010.

[3] F. Gale, J. Hansen, and M. Jewison. China's growing demand for agricultural imports. *Economic Information Bulletin*, 136, 2015.

[4] A. Golan, J. Judge, and S. Robinson. Recovering information from incomplete or partial multisectoral economic data. *Review of Economics and Statistics*, 76(3):541–549, 1994.

[5] J. Imb and I. Mejean. Trade elasticities: a final report for the european commission. Technical report, Economic and Financial Affairs, European Commission, 2010.

[6] R. Lam, X. Liu, and A. Schipke. China's labor market in the "new normal". *IMF Working Paper*, 151, 2015.

[7] X. Peng and Y. Mai. Population aging, labour market reform and economic growth in china - a dynamic general equilibrium analysis. General Paper No. G-174, September 2008.

[8] S. Robinson, A. Cattaneo, and M. Ei-Said. Updating and estimating a social account matrix using cross entropy methods. *Economic Systems Research*, 13(1), 2001.

[9] L. Taylor. *Structuralist Macroeconomics*. Basic Books Inc.: New York, 1983.

[10] L. Taylor. *Socially Relevant Policy Analysis*. MIT Press, 1990.

[11] R. Tyers and J. Golley. China's growth to 2030: demographic change and the labour supply constraint. PDGA Working Papers, 2006.

[12] R. Von Arnim and C. Rada. Labour productivity and energy use in a three-sector model: an application to egypt. *Development and Change*, 42(6), 2011.

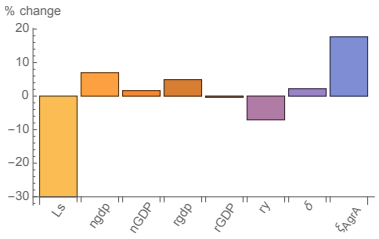
[13] D Willenbockel. Structural effects of a real exchange rate revaluation in china: a cge assessment. MPRA Paper No. 920, 2006.

[14] W. Zhang and D. Law. What drives china's food-price inflation and how it affects the aggregate inflation. Hong Kong Monetary Authority, 2010.

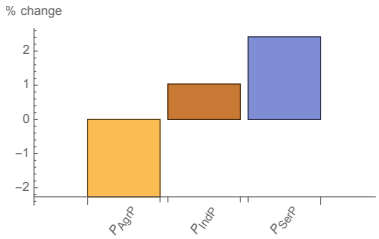
Appendix A: Overall changes from the dynamic model[10]

Figure 8: Full Effects of 5% Labor Force decrease

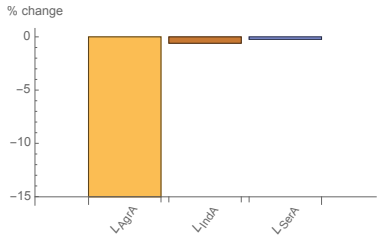
(a) Selected indicators



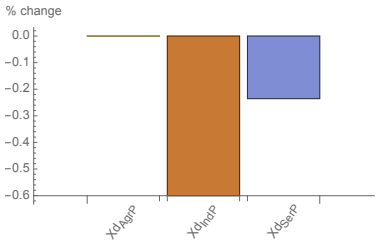
(b) Product prices



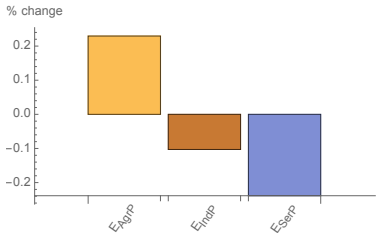
(c) Sectoral Employment



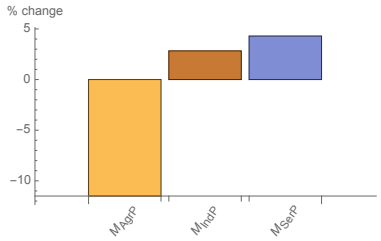
(d) Sectoral Production



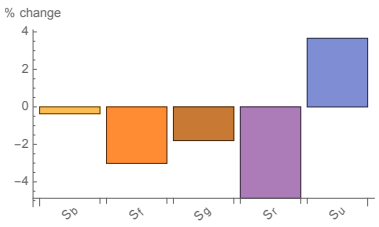
(e) Change in Exports



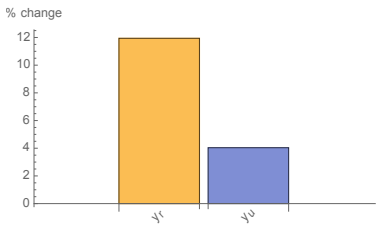
(f) Change in Imports



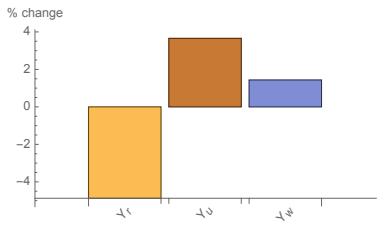
(g) Savings



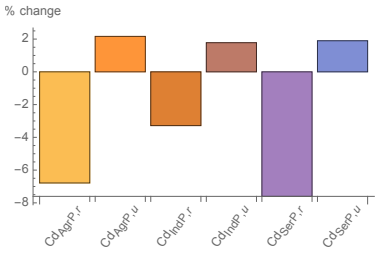
(h) Per Capita Income



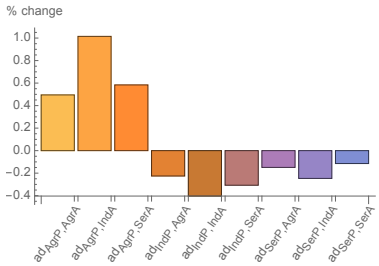
(i) Incomes



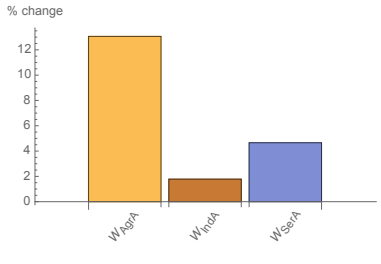
(j) Consumption of domestic products



(k) Intermediate domestic



(l) Sectoral Wages



[10]This figure shows the changes in the variables of the full dynamic model after all adjustments are (asymptotically) completed.

Appendix B: Sensitivity Analysis

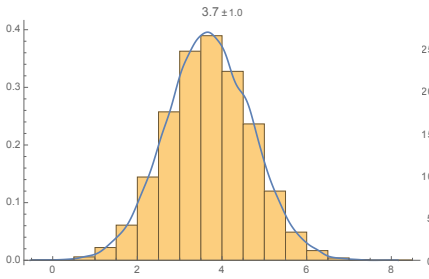
Sensitivity analysis is carried out to observe the level on uncertainty on solution variables given plausible error distributions of the parameters. Errors propagate with the deterministic shocks in the exogenous variables (e.g. LF changes) increasing the standard deviation of the distribution of the endogenous variables. We calculate the sample distribution of variables by generating a Monte Carlo sample of 15,000 solutions before and 15,000 solutions after after 5% labor force decrease. The samples are generated assuming a Gamma distribution of all elasticity of substitution (Armington elasticity) between domestic and imported intermediate consumption products in all sectors and the price elasticity of all exports. Figure 9 shows sample distribution of selected variables before and after 5% labor force decrease. In particular, panels 9a and 9b show the initial sample distribution of some parameters: the elasticity of substitution between domestic and imported intermediate agricultural products in the agricultural sector, $\sigma_{Agr,Agr}$, and the price elasticity of agricultural exports η_{Agr}. The number above the histogram is the calibration value and mean of the distribution, while the number in brackets is the assumed standard deviation. The remaining panels show selected variables distributions generated by the two samples "0" before the shock and "1" after the shock.

Figure 10 shows the box-whiskers charts of the distribution of selected variables before and after 5% labor force decrease. The two Monte Carlo samples of solutions are used to compare the before and after shock distributions in the box-whiskers charts. For instance panel 10a shows two distributions (in box-whiskers chart form). These are very concentrated around the mean and there is a clear reduction of L_{Agr} after the shock. Panel 10b shows the two distributions of L_{Ind} and that the box and whiskers of the distribution of the L_{Ind} after the shock is significantly larger than before the shock. Yet, there is still a clear increase in L_{Ind}. Panel 10h show the two box-whiskers distribution charts for the savings fo the RoW (the negative of the current account). Here the means of the distributions show an increase of Sf (a reduction of the current account surplus). Although, the latter quartile of the distribution after the shock overlaps with the distribution before the shows, we can be sufficiently confident that the Sf has increased.

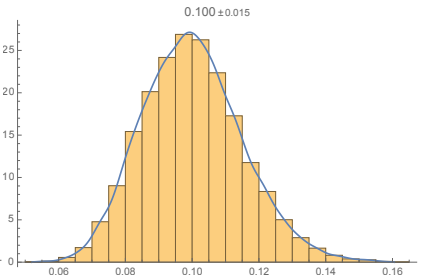
The sensitivity analysis shows overall robust simulation results even considering a large uncertainty in the main trade parameters.

Figure 9: Sample distribution of selected variables before and after 5% Labor Force decrease

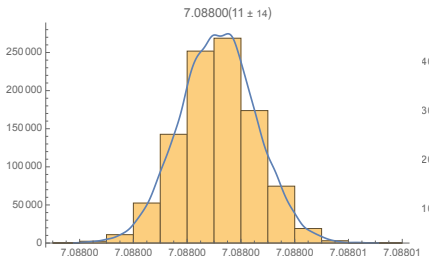
(a) elasticity of substitution Agr,Agr



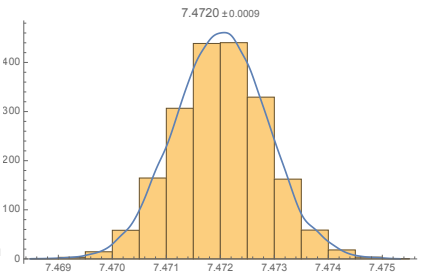
(b) price elasticity of exports Agr



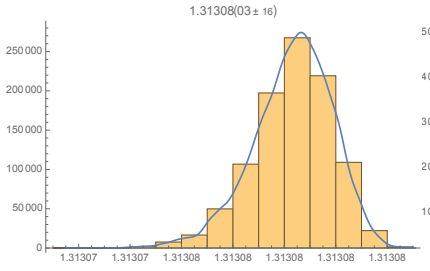
(c) GDP per capita const prices 0



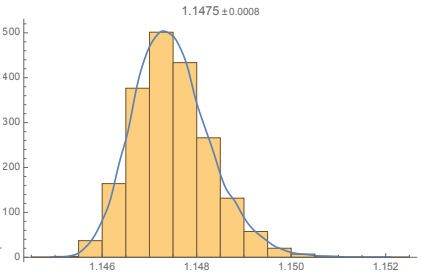
(d) GDP per capita const prices 1



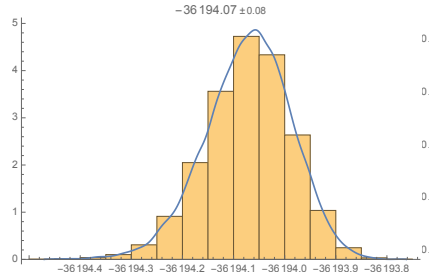
(e) relative per capita income 0



(f) relative per capita income 1



(g) Saving RoW (- current account) 0



(h) Saving RoW (- current account) 1

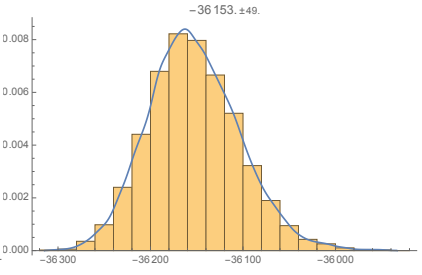
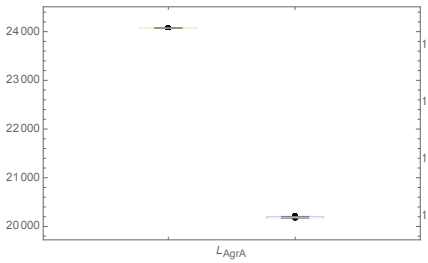
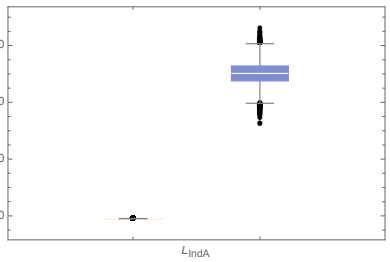


Figure 10: Box-whiskers charts of the distribution of selected variables before and after 5% labor force decrease

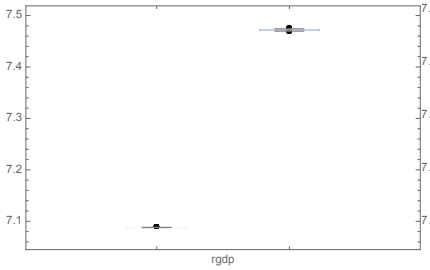
(a) Labor in agriculture



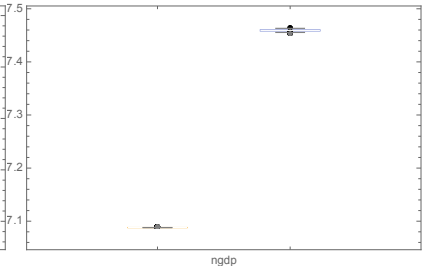
(b) Labor in industry



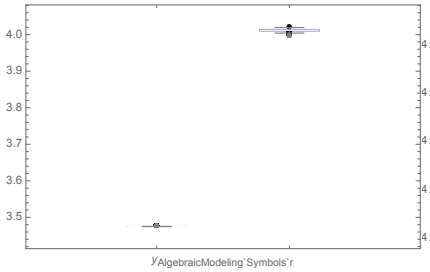
(c) GDP per capita const prices



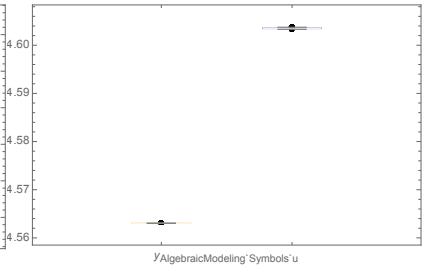
(d) GDP per capita current prices



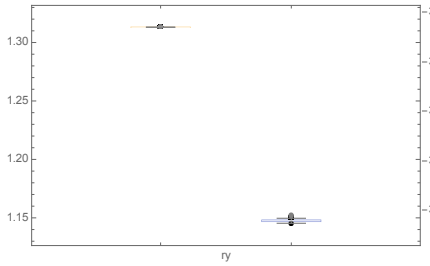
(e) Per capita income rural



(f) Per capita income urban



(g) relative per capita income



(h) Savings of RoW (- current account)