Decomposing China's Economic Growth From 2012 to 2022 – A Dynamic CGE Analysis

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Decomposing China's Economic Growth from 2012 to 2022 – A Dynamic CGE Analysis

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Abstract

China has experienced remarkable economic growth since its reform and opening-up in the early 1980s. Although growth has moderated as the economy has matured and undergone structural adjustment, China has maintained relatively strong performance, averaging 5–6% annually between 2010 and 2024. Using an economy-wide dynamic computable general equilibrium model of the Chinese economy, CHINAGEM, and a historical/decomposition approach, this study identifies the key drivers of growth over 2012–2017 and 2017–2022.

Productivity growth emerges as the dominant driver in both periods. In contrast, declining employment exerts a negative effect, which intensifies in 2017–2022 due to a sharper contraction in labour supply associated with population ageing. External demand and a rising preference for domestically produced goods also contributed positively to growth.

Looking ahead, the projected decline in China's working-age population will place sustained downward pressure on labour supply. These findings underscore the central role of productivity growth in offsetting demographic headwinds. Policies that foster technological progress and innovation, alongside investment in human capital and skills, will be critical to sustaining long-term economic growth.

JEL classification: O47, O53, C68

Key words: Economic Growth, Decomposition, Historical simulation, CGE model, China

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1. Introduction

Since the initiation of economic reforms in the late 1970s and China's progressive integration into the global economy during the 1980s, the Chinese economy has experienced one of the most remarkable episodes of sustained economic growth in modern economic history. Over the past four decades, China has transformed from a predominantly agrarian economy into the world's second-largest economy and a central player in global production and trade networks. During the early stages of reform, China recorded exceptionally high growth rates, with average annual GDP growth reaching approximately 9–10% from the 1980s through the first decade of the twenty-first century (World Bank, 2026). Although economic growth has moderated in recent years as the economy has matured and structural adjustments have taken place, China has continued to maintain relatively strong growth, averaging approximately 5–6% between 2010 and 2024 (World Bank, 2026).

China's sustained economic expansion has attracted extensive attention from economists and policymakers worldwide. A central question in this literature concerns the sources of China's economic growth. Identifying the factors that drive economic growth is important for understanding the sustainability of China's development model and for evaluating the implications of structural changes occurring within the Chinese economy. This question has become particularly relevant in recent years as China's economy has entered a period of slower but more balanced growth, accompanied by demographic changes (Peng 2022), industrial upgrading, and increasing uncertainty in the global economic environment.

While numerous studies have examined the determinants of China's growth using various methods, relatively few have employed computable general equilibrium (CGE) models to decompose growth into the contributions of different drivers. Using a dynamic CGE model of the Chinese economy, Peng and Adams (2023) conducted a decomposition analysis of economic growth for the period 2012–2019, finding that productivity improvement was the primary driver, although increasing demand for Chinese goods and services also contributed significantly. Building on this earlier work, the present study extends the analysis in two key ways: First, it extends the research period to 2012–2022, incorporating recent economic developments, including structural adjustments and the disruptions associated with the COVID-19 pandemic. The period is further divided into 2012–2017 and 2017–2022, allowing comparison of growth drivers across these two sub-periods. Second, it explicitly introduces economic momentum as an additional component of economic change within the CGE framework. As discussed later, economic momentum isolates the economic consequences of the surplus of domestic savings over the level of investment required to maintain the capital stock at its initial level.

The remainder of the paper is organised as follows. Section 2 reviews the relevant literature on the sources of China's economic growth and the application of CGE models in growth decomposition analysis. Section 3 describes the dynamic CGE model and the methodology used in the decomposition analysis. Section 4 presents the historical simulation results. Section

5 discusses the decomposition simulation results in detail and Section 6 provides conclusions and policy implications.

2. Literature Review

Understanding the sources of China's economic growth has been a central question in development economics and China studies for decades. Existing studies generally fall into three main strands: growth accounting analyses, econometric studies of growth determinants, and economy-wide modelling approaches.

The first strand applies growth accounting methods to decompose economic growth into contributions from capital accumulation, labour input, and total factor productivity (TFP), building on the foundational work of Solow (1957) and Denison (1962). Early studies focusing on China, such as Wang and Yao (2001), find that both physical and human capital accumulation contributed significantly to post-reform economic expansion, while TFP gains played an increasing role in later years. Du et al. (2014) further demonstrate that physical capital accumulation dominated output growth during the late 1990s and early 2000s, although technical efficiency improvements also became important. Regional studies confirm that TFP growth has contributed to provincial growth differences (Zhu, 2012; Brandt et al., 2013).

The second strand of literature uses econometric methods to identify growth determinants. Empirical studies highlight the roles of high investment rates, labour force expansion, human capital accumulation, trade openness, and foreign direct investment. Integration into global markets, particularly following China's WTO accession in 2001, significantly boosted exports, technology adoption, and industrial upgrading (Borensztein & Ostry, 1996; Lee & Hong, 2012). Human capital accumulation has also been shown to play an important role in sustaining productivity gains (Whalley & Zhao, 2010).

While growth accounting and econometric analyses provide valuable insights, they often abstract from the complex interactions among sectors and economic agents. CGE models offer an alternative, structural approach that explicitly represents these interactions. CGE models are particularly suited to evaluating how different growth drivers - such as productivity changes, labour dynamics, investment behaviour, and policy interventions - jointly influence macroeconomic outcomes. Exploiting these CGE strengths, the historical/decomposition method has been developed over three decades to decompose the economic growth of a country or a region or many countries. Applied first to Australia's national economy (Dixon & McDonald 1993, Dixon et al. 2000, Dixon & Rimmer 2002, Giesecke 2008a), then extended to regional analysis (Giesecke 2002, 2008b), other nations (Dixon & Rimmer 2004, Giesecke & Tran 2009), and mostly recently to the globe (Dixon and Rimmer 2023).

Despite the above studies, relatively few studies have applied dynamic CGE frameworks to decompose China's economic growth. Peng and Adams (2023) conducted such an analysis for 2012–2019, finding productivity growth as the primary driver while labour force increase and aggregate demand contributed as secondary factors. However, their study did not account for economic momentum, an additional driver of economic change arising from the surplus of domestic savings over depreciation investment. Other CGE-based studies examine demographic change and structural transitions (Liu et al., 2013), but systematic decomposition of growth with momentum remains rare.

In this study, we aim to examine a range of questions related to the recent history of China's economic development, including why China's economic growth was fast between 2012 and 2017 and why it slowed down between 2017 and 2022.

3. Methodology and Modelling Framework

The model we will use in this research is a dynamic computable general equilibrium model of the Chinese Economy, CHINAGEM (Peng, 2023), which includes 157 sectors and its base data reflects the 2012 input-output structure of the Chinese economy. Its core CGE structure is based on ORANI, a static CGE model of the Australian economy (Dixon et al 1982). Its dynamic mechanisms are based on the MONASH model of the Australian economy (Dixon and Rimmer, 2002). The model is solved using GEMPACK (Horridge et al. 2018).[1]

In CHINAGEM, production is modelled using nested constant elasticity of substitution (CES) and Leontief production functions which allow substitution between domestic and imported sources of produced inputs and between labour, capital and land. The production functions are subject to constant returns to scale. Household demand is modelled by the linear expenditure system (LES). Trade is modelled using the Armington assumption for import demand and a constant elasticity of transformation (CET) for export supply. Import prices are determined in world markets. Exports are demanded according to constant-elasticity demand curves for most commodities. In the model, capital stock is accumulated through investment activities (net of depreciation). Investors respond to changes in expected rate of return. China's net foreign liability (asset) is accumulated through saving, investment and changes in debts and equities. There is a lagged adjustment in the labour market where real wage is sticky in the short term. If the policy shock causes the employment to deviate from its baseline value, then real wage will adjust in order to make the employment gradually return to its baseline level.

CHINAGEM can be used to conduct four types of simulations: historical, forecast, policy, and decomposition simulations. In this study, we employ two simulation modes: historical and decomposition. As discussed by Dixon and Rimmer (2002), decomposition analysis requires first conducting a historical simulation to estimate the changes in a number of unobservable variables, such as the average propensity to consume (APC) and technological progress (e.g., labour-augmenting technical change). These variables are termed unobservable because their movements cannot normally be directly observed in official statistical sources such as national statistical yearbooks. Within a CGE framework, however, their changes can be inferred through a historical simulation. The results generated from the historical simulation are then used in the

[1] We use the Runge-Kutta solution method, applying GEMPACK's default convergence criteria and numerical tolerances for this method (see Horridge et al. (2018) for details).

decomposition simulation to evaluate the contributions of these unobservable variables to economic growth and other economic outcomes.

In standard CGE models, these unobservable variables are usually specified as exogenous unless explicit behavioural equations or theoretical mechanisms are available to explain their movements. To estimate their changes, they must first be endogenised (Column 2, Table 1) by swapping them with variables that are typically endogenous in the model but observable in statistical data (Column 1, Table 1). These observable variables include key macroeconomic indicators such as investment, imports, and exports. In the historical simulation, the observed changes in these variables over the period of interest are imposed as shocks, allowing the model to infer the corresponding movements in the unobservable variables.

In the decomposition simulation, the unobservable variables are exogenised again (Column 2, Table 1), and the values estimated from the historical simulation are introduced as shocks to assess their contributions to economic growth. The process of assigning variables between exogenous and endogenous status is referred to as the choice of model closure (Dixon and Rimmer, 2002; Peng and Adams, 2023). Table 1 displays the closure choices for the key variables that define our historical and decomposition simulations from 2012 to 2022.

Table 1: Categories of variables in historical and decomposition closures

Selected exogenous variables in the historical simulation (These variables are endogenous in decomposition simulation)	**Corresponding endogenous variables in the historical simulation (These variables are exogenous in decomposition simulation)**
Government consumption (G)	Ratio of government consumption/household consumption
Household consumption (C)	Average propensity to consume out of GNP
Investment (I)	Investment/capital ratio
Import (M)	preference for imported goods
Terms of Trade	Shift in the foreign demand curve
Export (X)	All-factor augmenting technical change
Share of wage over GDP	Cost-neutral change in labour/capital ratio for all industry resulting from technology change (twist towards labour)
Selected exogenous variables in both historical and decomposition closure	
Population; Share of the population that is of working age; Labour force participation rate; Employment rate.	
Selected endogenous variables in both historical and decomposition closure	
Capital growth; Employed persons.	

As China's population has declined since 2022, with its labour force declining even earlier, it is important to accurately assess the impact of demographic changes on China's economic growth over the period 2012–2022. To this end, we introduce an equation linking the working-age population, labour force, and employment:

$$Employment_t = Population_t * \frac{Workingage\ POP(15+)_t}{Population_t} * \frac{Labur\ force(15+)_t}{Workingage\ POP(15+)_t} * \frac{Employment_t}{Labour\ force\ (15+)_t} \quad (1)$$

In this equation,

$\frac{Workingage\ POP(15+)_t}{Population_t}$ is the share of the population aged 15 and above (SWA) at year t;

$\frac{Labur\ force(15+)_t}{Workingage\ POP(15+)_t}$ is the labour force participation rate (LFPR) of the working-age population at year t;

$\frac{Employment_t}{Labour\ force\ (15+)_t}$ is s the employment rate (ER) at year t.

Equation (1) can thus be simplified as:

$$Employment_t = POP_t * SWA_t * LFPR_t * ER_t \quad (2)$$

Where POP_t denotes the total population in year t. Equation (2) indicates that total employment in a country in year t is the product of population, the share of working-age population, labour force participation rate, and employment rate in year t. As noted in Table 1, POP_t, SWA_t, $LFPR_t$ and ER_t are treated as exogenous in both the historical and decomposition simulations and shocked equal to their historically observed values.

In the simulations conducted in this study, rather than decomposing economic growth from 2012 to 2022 in a single step, we divide the period into two five-year sub-periods: 2012–2017 and 2017–2022. Our analysis focuses not only on economic growth within each sub-period but also on comparing growth across the two sub-periods. The initial solution is based on 2012, which is the database year of the CHINAGEM model used in this study, and the movements in both exogenous and endogenous variables are measured over the two five-year intervals.

4. Historical simulation

4.1 Movements of exogenous variables

Using data from the World Bank Development Indicators and the 2023 China Statistical Yearbook, we calculate the changes in key macroeconomic variables, expressed in real terms at constant prices (Table 2).

Table 2: Chinese Economic Growth (%)

	2012 to 2017	2017-2022
Real GDP	41.6	29.2
Real aggregate government consumption (G)	44.1	23.8
Real aggregate household consumption (C)	51.5	21.2
Real aggregate investment (I)	38.6	24.3
Real aggregate imports (M)	35.1	5.87
Real aggregate exports (X)	20.2	12.4
Terms of Trade	11.6	-3.4
Wage share in GDP	4.34	-0.89
Population	3.0	0.83
Share of population of working age	-0.36	-0.16
Labour force participation rate	-2.39	-3.40
Employment rate	-0.44	-0.83

Sources: World Bank Development Indicators; China Statistical Yearbook 2023.

From 2012 to 2017, China's real GDP grew rapidly, increasing by more than 40%. Both real household and government consumption grew even faster than GDP. Investment expanded by nearly 40%, slightly slower than GDP growth, but still substantial. Trade growth, however, lagged behind GDP: imports increased by 35%, while exports grew by only 20%.

In contrast, over 2017–2022, economic growth slowed markedly. Real GDP grew by only 29%, nearly one-third lower than in the previous period. The COVID-19 pandemic from 2020 to 2022 was likely an important factor, but trade tensions with the U.S. possibly also contributed to the slowdown. Imports rose by less than 6%, and exports increased by 12%.

Regarding income distribution, the share of wages in GDP rose by 4.34% in 2012–2017, but declined by 0.89% in 2017–2022. Terms of trade improved in the first period but deteriorated in the second period, a pattern that will be explored further in the decomposition analysis.

Demographically, although China's population grew in both periods, growth slowed considerably in 2017–2022. Moreover, the working-age population, labour force participation rate, and employment rate all declined in both periods, with particularly larger declines in rates of labour force participation and employment during the second period.

4.2 Historical simulation results

We impose the changes in the macroeconomic variables listed in Table 2 (also shown in Column 1 of Tables 3 and 4) as shocks to the model, which generates the corresponding movements in the endogenous variables. The results are reported in Column 2 of Tables 3 and 4.

Table 3: Shocks and results of the historical simulation (2012 to 2017, %)

Exogenous macro variables	Growth rate	Corresponding endogenous variables	Growth rate
Real aggregate government consumption (G)	44.1	Ratio of government consumption/household consumption (G/C)	**-4.88**
Real aggregate household consumption (C)	51,5	Average propensity to consume	**4.10**
Real aggregate investment (I)	38.6	Investment/capital ratio	**3.40**
Real aggregate imports (M)	35.1	Preference towards imported goods	**-36.71**
Terms of trade	11.6	Shift in the foreign demand curve	**66.95**
Real aggregate exports (X)	20.2	All-factor augmenting technical improvement (input requirements per unit of output)	**-16.16**
Wage share in GDP	4.34	Cost-neutral change in labour/capital ratio resulting from technology change (twist towards labour)	**-10.72**
Population	3.0		
Share of working age population	-0.36	Employment (persons)	**-0.26**
Labour force participation rate	-2.39		
Employment rate	-0.44		
		Capital stock	**36.71**

Sources: Data in column 1 are from World Bank Development Indicators and China Statistical Yearbook 2023. Results in column 2 are from CHINAGEM historical simulation.

We find that in the first period (2012–2017), the ratio of government consumption to household consumption (G/C) declined by 4.9% (Column 2, Table 3), indicating that growth in public consumption was damped relative to growth in private consumption. In contrast, during the second period (2017–2022), G/C increased by over 2%, likely reflecting the government's increased spending to support households and firms during the COVID-19 pandemic, while household consumption likely fell due to lockdowns (Table 4).

The average propensity to consume, calculated as the sum of government and household consumption over GDP, rose by more than 4% in the first period but declined by almost 5% in the second period, again reflecting the economic impact of pandemic-related restrictions.

The investment-to-capital ratio, an indicator of business confidence, increased slightly in the first period but rose more substantially in the second period. This may reflect government-led investment initiatives aimed at stimulating the economy during the pandemic.

Consumer preferences towards imported goods decreased sharply in the first period, by nearly 37%, suggesting a strong shift towards domestically produced goods by Chinese producers and households. This high rate of import replacement likely reflected growing confidence in the quality and reliability of domestic production. In the second period, the shift away from imports and toward domestic sources continued, but at a slower pace (13.75%). Similarly, the shift in the foreign demand curve, which reflects the demand for Chinese goods in international markets, showed a substantial positive increase (67%) in the first period, consistent with rapid penetration of foreign markets by Chinese producers. This growth slowed dramatically in the second period, to 1.4%. This likely reflects a combination of factors. In particular, the end period for the simulation coincides with the period of pandemic-related border closures, and trade frictions with the United States.

China experienced substantial technological improvements in both periods. Input requirements per unit of output fell by 16.16% over the first period, equivalent to an improvement in all-factor augmenting technical efficiency of 19.3%. Over the second five-year period, input requirements per unit of output fell by 12.98%, equivalent to an increase in output augmenting technical efficiency of 14.9%. These are high rates of technical efficiency improvement, but indicate a slowing in the second period. Over the first period, the annual average rate of growth in output-augmenting technical efficiency was 3.6%, while over the second period it fell to 2.8%.

In both periods, the labour/capital ratio declined due to technological change, implying a shift in production techniques towards greater capital intensity, which we report in Tables 3 and 4. This shift is cost-neutral between capital and labour, indicating that industries increasingly substituted capital for labour at the prevailing input prices. This pattern is consistent with broader trends in automation, digitalisation, and process modernisation in China over the past decade.

Changes in population, working-age population share, labour force participation rate, and employment rate translate into changes in total employment, calculated using Equation 2. Employment declined in both periods, with a modest drop of 0.26% in the first period and a much larger decline of 3.56% in the second period, reflecting population ageing and lower labour force participation and employment rates.

China's capital stock grew by over 36% in the first period, but the growth rate dropped to 21% in the second period, consistent with slower growth in GDP and technical efficiency, and the fall in employment.

In summary, China sustained rapid economic growth over 2012–2022, although growth slowed in the latter five years. Some unobservable variables, such as all factor augmenting technical change, maintained high growth throughout the decade, whereas others, such as the shift in foreign demand, increased sharply in the first five years but slowed dramatically in the second. The individual and joint contributions of these unobservable variables to China's economic growth are analysed in next section.

Table 4: Shocks and results of the historical simulation (2017 to 2022, %)

Exogenous macro variables	Growth rate	Corresponding endogenous variables	Growth rate
Real aggregate government consumption	23.8	Ratio of government consumption/household consumption (G/C)	**2.12**
Real aggregate household consumption	21.2	Average propensity to consume	**-4.70**
Real aggregate investment	24.3	Investment/capital ratio	**4.14**
Real aggregate imports	5.87	Preference towards imported goods	**-13.75**
Terms of trade	-3.4	Shift in the foreign demand curve	**1.36**
Real aggregate exports	12.4	All-factor augmenting technical improvement	**-12.98**
Share of wage over GDP	-0.89	Twist towards labour (twistlab)	**-11.93**
Population	0.83		
Share of working age population	-0.16		
Labour force participation rate	-3.40	Employment (persons)	**-3.56**
Employment rate	-0.83		
		Capital stock	**21.17**

Sources: Data in column 1 are from World Bank Development Indicators online and China Statistical Yearbook 2023. Results in column 2 are from CHINAGEM historical simulation.

5. Decomposition of China's economic growth

As we discussed in Section 3, in the decomposition simulation structural variables are exogenous as we displayed in Column 2, Table 1. By setting these variables at their values estimated from the historical simulation (Column 2, Tables 3 and 4), we generate model results in the decomposition simulation for consumption, investment and other endogenous variables identical to those in the historical simulation shown in Table 2 and column 1, Tables 3 and 4. This allows us to attribute the historical movements in economic variables such as real GDP to the individual contributions made by movements in each of the structural variables over the period.

In this section, we will first discuss the decomposition closure, then we will analyse the decomposition results shown in Table 5, column by column.

5.1 The structure of macroeconomic causation in the decomposition simulation

For understanding the results in Table 5, following Dixon and Rimmer (2002, 2004), we use a flow diagram displayed in Figure 1 to help us. This flow diagram is for a one-commodity CGE model, therefore, it does not illustrate relative-price or other structural effects. While these are important, Figure 1 is, nevertheless, a helpful representation of the main macro assumption underlying our CHINAGEM decomposition simulation. It uses the period 2012 to 2017 as an example. The assumption and framework are the same in the period 2017 to 2022.

When we explain Figure 1, we will use the simulation period of 2012 to 2017 as an example. The theory we will explain applies to the simulation period of 2017 to 2022.

Lines (1), (2) and (3) describe a production function: the change in output (ΔGDP) between 2012 and 2017 is a function of ΔTECH (technology), ΔL (labour) and ΔK (capital). We assume that capital earns the value of its marginal product, hence the physical marginal product of capital (MPK) is equal to the ratio of the rental price of capital to the price of the output. In a one-commodity model, the price of the product can represent the asset price of capital. Therefore, rate of the return on capital (ROR) can be represented by the rental/asset price ratio. Under constant-returns to scale (assumed in CHINAGEM), the MPK function is a function of K/L, TECH and twistlab. Thus ΔK is determined by ΔTECH, ΔL, ΔROR and Δtwistlab (lines (4), (5) (6) and (7)).

In our decomposition simulation, ΔROR is exogenous as indicated in Figure 1. When we are focused on analysing the effects of particular shocks over periods as long as five years (2012 to 2017) it is appropriate to assume that capital adjusts to restore rates of return. For instance, in isolating the effects of technology changes between 2012 and 2017, we assume that rates of return are unaffected. i.e. ΔROR =0.

With capital earning the value of its marginal product, labour also is paid according to the value of its marginal product. Therefore, via the factor-price frontier (the relationship between the MPK, MPL and TECH, Samuelson, 1962), ΔROR and ΔTECH determined the real wage rate. This is indicated by lines (8) and (9) in Figure 1.

Exogenisation of the rate of return can be thought of as determining the capital stock in 2017. While determining capital stocks for 2017 also determines aggregate investment between 2012 and 2017, it does not determine investment in 2017. We link investment in 2017 to capital in 2017 (line (10) in Figure 1). In isolating the effects of changes in technology etc, we assume that such changes have no impact on business confidence regarding prospects for future capital returns. Thus, we treat the investment/capital ratio (the gross capital growth rate) as exogenously determined.

Lines (11) and (12) describe the calculation of the change in gross national product between 2012 and 2017 (ΔGNP). This is GDP subtracting the change in net interest/dividend payments to foreigners (a proportion of the change in start-of-year net foreign liabilities, ΔNFL. We assume in line (13) that the changes in household and government consumption (ΔC, ΔG) are exogenously given proportions of the change in GNP (that is, the average propensity to consume out of GNP is given). With ΔGDP, ΔC, ΔG and ΔI now determined, the change in the balance of trade (ΔBOT) is determined as a residual.

Figure 1: Macro connections in the decomposition simulation for 2012 to 2017 and 2017 to 2022

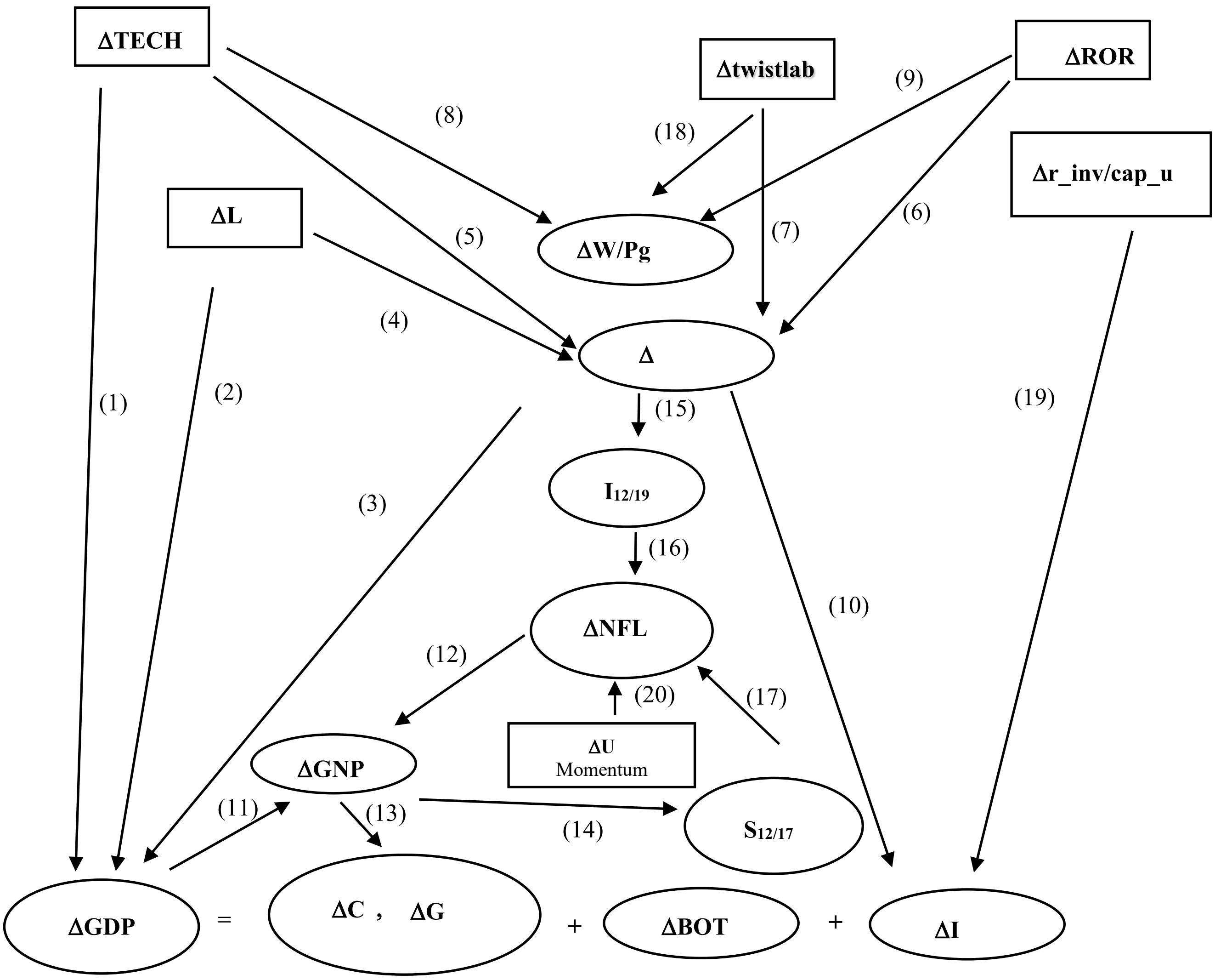

Table 5: Decomposition results 2012 to 2017, and 2017 to 2022 (%) (columns 1 – 5)

Macroeconomic Variables	1 Technical change		2 Import / domestic preferences		3 Foreign demands & import prices		4 Population growth & labour market		5 Labour / capital bias in technical change	
	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22
1. Real GDP	26.9	19.6	0.5	0.1	3.4	0.1	-0.4	-3.7	6.0	6.0
2. Real GNP	24.0	17.4	1.6	0.4	5.4	0.1	-0.4	-3.1	4.4	4.3
3. Real GNE	19.8	14.2	1.6	0.4	4.4	0.1	-0.4	-3.3	7.5	7.5
4. Real private consumption	26.1	17.9	1.1	0.3	4.5	0.1	-0.4	-3.1	4.5	4.2
5. Real investment	13.9	10.1	2.2	0.5	4.5	0.1	-0.5	-3.6	11.3	11.8
6. Real public consumption	25.4	18.1	1.1	0.3	4.4	0.1	-0.4	-3.1	4.4	4.2
7. Export volumes	34.2	27.2	-19.4	-5.9	21.6	0.5	-0.3	-3.6	1.2	0.7
8. Import volumes	-1.5	-2.6	-21.6	-6.0	34.1	0.8	-0.2	-1.2	7.4	7.9
9. Population	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.8	0.0	0.0
10. Share aged 15+	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.2	0.0	0.0
11. Participation rate	0.0	0.0	0.0	0.0	0.0	0.0	-2.4	-3.4	0.0	0.0
12. Employment rate	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.8	0.0	0.0
13. Employment	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-3.6	0.0	0.0
14. Capital stock	14.3	10.3	2.1	0.5	4.8	0.1	-0.4	-3.5	11.9	12.3
15. Land supply	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16. Real wage	33.0	23.8	2.9	0.7	6.5	0.1	0.1	1.1	-1.5	-1.9
17. Real exchange rate depreciation	12.0	10.9	-6.5	-2.3	-12.2	-0.3	-0.1	-1.5	0.4	0.3
18. Real exchange rate appreciation	-14.1	-10.5	7.7	2.2	14.1	0.3	0.1	1.4	-0.5	-0.3
19. Terms of trade	-10.9	-8.5	6.2	1.8	11.1	0.3	0.1	1.1	-0.4	-0.2
20. Nominal exchange rate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21. Change in NFL / GDP ratio	0.3	0.3	0.0	0.0	0.1	0.0	0.0	-0.1	0.4	0.4
22. 100 x change in BOT / GDP ratio	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23. GDP deflator (at market prices)	-14.1	-10.5	7.7	2.2	14.1	0.3	0.1	1.4	-0.5	-0.3

Macroeconomic Variables	1 Technical change		2 Import / domestic preferences		3 Foreign demands & import prices		4 Population growth & labour market		5 Labour / capital bias in technical change	
	2012-17	**2017-22**	**2012-17**	**2017-22**	**2012-17**	**2017-22**	**2012-17**	**2017-22**	**2012-17**	**2017-22**
24. Average capital rental price	-10.3	-8.1	6.0	1.8	10.8	0.3	0.1	1.2	-0.4	-0.3
25. Producer price index	-11.5	-8.8	6.7	2.0	11.9	0.3	0.1	1.2	-0.3	0.0
26. Consumption deflator	-13.2	-10.0	7.0	2.0	12.9	0.3	0.1	1.3	-0.3	0.0
27. Investment deflator	-10.5	-8.2	6.1	1.8	11.0	0.3	0.1	1.2	-0.4	-0.3
28. Government deflator	-14.2	-10.7	7.1	2.0	13.3	0.3	0.1	1.5	-0.9	-0.8
29. Export deflator	-10.9	-8.5	6.2	1.8	11.1	0.3	0.1	1.1	-0.4	-0.2
30. c.i.f. import price deflator	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5 (cont'd): Decomposition results 2012 to 2017, and 2017 to 2022 (%) (columns 6 – 11)

Macroeconomic Variables	6 Public / private spending		7 Propensity to consume		8 Investment / capital ratio		9 Rate of return		10 Momentum		11 Total	
	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22
1. Real GDP	0.0	0.0	0.9	-1.0	0.7	0.8	0.0	0.0	1.3	1.3	39.2	23.1
2. Real GNP	0.0	0.0	1.0	-1.2	0.9	1.0	-0.2	-0.1	8.1	8.4	44.7	27.2
3. Real GNE	0.0	0.0	3.7	-4.1	2.6	2.9	-0.8	-0.3	5.1	5.2	43.5	22.6
4. Real private consumption	1.6	-0.6	5.8	-6.1	0.8	0.9	-0.2	-0.1	7.9	7.8	51.7	21.2
5. Real investment	0.0	0.0	1.7	-1.8	4.8	5.5	-1.5	-0.6	2.3	2.3	38.7	24.3
6. Real public consumption	-4.5	1.7	5.6	-6.2	0.8	0.9	-0.2	-0.1	7.7	7.8	44.3	23.8
7. Export volumes	0.0	0.0	-6.7	9.0	-4.1	-5.5	2.9	1.4	-9.3	-11.5	20.2	12.3
8. Import volumes	0.1	0.0	5.4	-6.7	4.5	5.4	-0.4	-0.2	7.4	8.5	35.1	5.9
9. Population	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.8
10. Share aged 15+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.2
11. Participation rate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.4	-3.4
12. Employment rate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.8
13. Employment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	-3.6
14. Capital stock	-0.1	0.1	1.4	-1.5	0.8	0.9	0.3	0.2	1.9	1.9	36.9	21.2
15. Land supply	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16. Real wage	-0.1	0.0	1.4	-1.5	0.8	0.9	-0.8	-0.3	1.9	1.9	44.1	24.8
17. Real exchange rate depreciation	0.0	0.0	-2.5	3.7	-1.4	-2.2	0.4	0.3	-3.4	-4.8	-13.5	4.1
18. Real exchange rate appreciation	0.0	0.0	2.9	-3.6	1.7	2.1	-0.4	-0.3	4.0	4.6	15.6	-3.9
19. Terms of trade	0.0	0.0	2.2	-2.8	1.3	1.7	-0.9	-0.4	3.0	3.6	11.6	-3.4
20. Nominal exchange rate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21. Change in NFL / GDP ratio	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	-1.3	-1.4	-0.4	-0.8
22. 100 x change in BOT / GDP ratio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0

Macroeconomic Variables	6 Public / private spending		7 Propensity to consume		8 Investment / capital ratio		9 Rate of return		10 Momentum		11 Total	
	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22	2012-17	2017-22
23. GDP deflator (at market prices)	0.0	0.0	2.9	-3.6	1.7	2.1	-0.4	-0.3	4.0	4.6	15.6	-3.9
24. Average capital rental price	0.0	0.0	2.1	-2.8	1.3	1.7	-0.4	-0.3	2.9	3.6	12.2	-2.9
25. Producer price index	0.0	0.0	2.4	-3.1	1.4	1.8	-0.4	-0.2	3.3	3.9	13.6	-3.0
26. Consumption deflator	0.0	0.0	2.7	-3.4	1.5	2.0	0.1	0.0	3.7	4.4	14.6	-3.6
27. Investment deflator	0.0	0.0	2.2	-2.9	1.3	1.8	-0.2	-0.2	3.0	3.7	12.6	-2.9
28. Government deflator	-0.1	0.1	2.9	-3.7	1.6	2.0	-1.1	-0.6	4.0	4.7	12.9	-5.1
29. Export deflator	0.0	0.0	2.2	-2.8	1.3	1.7	-0.9	-0.4	3.0	3.6	11.6	-3.4
30. c.i.f. import price deflator	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Line (14) links accumulated excess savings ($S_{12/17}$) to ΔGNP. $S_{12/17}$ is the differences between the value of the accumulated saving over the period 2012 to 2017 and the value it would have had in the absence of any change over the period in GNP. In deriving the link between $S_{12/17}$ and ΔGNP, we assume that saving in each year between 2012 and 2017 is a fixed proportion of GNP. Under a smooth growth assumption applied to GNP, this allows us to specify the accumulated excess savings as a function of ΔGNP.

By again invoking a smooth growth assumption, we can specify in our model the excess accumulated cost of investment ($I_{12/17}$) between the beginning of 2012 in terms of the change between these two dates in the capital stock (ΔK). The excess cost of investment is the difference in the value of the accumulated investment and the value it would have had in the absence of any change over the period in the aggregate capital stock. The link between $I_{12/17}$ and K is indicated in Figure 1 by line (15).

Another set of relations in Figure 1 are line (16), (17) and (20). They determine ΔNFL as a combination of three components: $I_{12/17}$ minus $S_{12/17}$ plus momentum. Momentum is the change in NFL, which would have occurred in the absence of either excess accumulated savings or excess accumulated investment, that is the change in NFL that would have occurred in the absence of changes in GNP and K. Momentum consists of accumulated interest payment between 2012 and 2017 on the net foreign liabilities of 2012 plus depreciation investment (that is the investment required to maintain the capital stock at its 2012 level) minus static saving (that is the accumulated value of saving that would have occurred in the absence of any change in GNP). Momentum is recognized in CHINAGEM simulations via movement from zero to one in a homotopy variable, U[2].

In this decomposition exercise, we also involve two exogenous variables *twistlab* (cost-neutral changes in the labour/capital ratio arising from technological change) and *r_inv_cap_u* (the ratio of investment to capital for the whole economy). As we explained in the last section, the shock to *twistlab* will change the demand for capital relative to labour. It also affects the real wage rate. With exogenous employment (ΔL), the change to *twistlab* (Δ*twistlab*) will affect capital (line (7)) and real wage rate (line (18)). The shock to *r_inv_cap_u* will affect the investment/capital ratio and directly affect investment (line (19)).

5.2 Decomposition results analysis

The last column in Table 5 shows the results of the decomposition simulation for macro variables of the Chinese economy from 2012 to 2017, and 2017 to 2022. Columns 1 to 10 provide a decomposition of these outcomes, computed using the algorithm of Harrison, Horridge and Pearson (2000) to decompose the movements in the endogenous variables into the individual contributions made by each of the shocked exogenous variables. We will start to analyse the decomposition results by looking at each factor from columns 1 to 10 individually.

[2] Please refer to Dixon and Rimmer (2002) for the details about the homotopy variable.

5.2.1 Column 1: All-factor augmenting technical improvement

The macro effects of the historically estimated movements in productivity (all-factor augmenting technical improvement) are shown in column 1 of Table 5. We notice that China has experienced rapid technical improvements in both periods: a 16.16% improvement in first period, with the pace of productivity growth slower in the second period, at 12.98%. With given employment and given rates of return on capital, technical improvements increase the real wage rate and increase GDP directly via the production function (line (1), Figure 1) and indirectly via increase in the capital stock (lines (5) and (3)). Table 5 shows that technical changes drive the capital stock to increase by 18.4% and 10.3% in periods 1 and 2, respectively (row 14).

The rise in GDP causes GNP (row 2) to be higher (lines (11) and (12), Figure 1), however the additional savings generated by the rise in GNP are not sufficient to fund the investment required to generate the higher capital stock outcomes reported in row 14 (lines 16-17). As a result, net foreign liabilities must rise as a proportion of GDP (row 21) (lines (12)). This leads to a lower growth in real GNP (24% for period one and 17.4% for period one, row 2) relative to real GDP (26.9% and 19.6% for periods one and two, respectively, row 1). Real consumption (household, C and government, G) is linked to GNP via an exogenous propensity to consume (line (13)). Hence, real household and government consumption spending rise by less than the increase in real GDP (rows 4 and 6). Real investment (I) also rises by less than the increase in real GDP because the capital stock increase is smaller than the real GDP increase (13.9% for period one and 10.1% for period two, row 5).

Based on the GDP identity (GDP=C+G+I+X-M), with similar percentage increases in C, G and GDP, the lower increase in I relative to GDP implies that the balance of trade has to move towards surplus. The mechanism is real devaluation (12.0% for period one and 10.9% for period two, row 17), which stimulates exports (34.2% for period one and 27.2% for period 2, row 7) and reduces imports (-1.5% for period one and -2.6% for period 2, row 8). The expansion in exports causes a deterioration of the terms of trade (-10.9% for period one and -8.5% for period 2, row 19). The greater expansion in export volumes relative to import volumes (rows 7 and 8) drives the increase in the balance of trade / GDP ratio (row 22).

5.2.2 Column 2: Import/domestic preferences

In the historical simulation, economy-wide import volumes are exogenous, and an economy-wide twist in preferences for imported versus domestically produced goods is determined endogenously. Column 2 isolates the effects of the shifts in import/domestic preferences over the two five-year periods. Over both periods, the preference movement was towards domestically-sourced goods and away from imports. This shift was strongest in the first five-year period, as is apparent from the results for economy-wide import volumes over the two periods (row 8, column 2). By construction, the import twists are cost-neutral and thus have little impact on real GDP (row 1) or the capital stock (row 14)). Hence, there is little change in real GNE (row 3) relative to real GDP (row 1), and thus, little change in the balance of trade to GDP ratio (row 22). Therefore, the decline in import volumes must be approximately matched by a decline in export volumes (row 7). This causes the terms of trade to increase (row 19). which, ceteris paribus, accounts for the small increase in the capital stock (row 14) and real GDP (row 1).

5.2.3 Column 3: Foreign demands

In the historical simulation, China's terms of trade are determined exogenously, and a uniform (across all commodities) shift in the position of China's export demand schedules is determined endogenously. In the decomposition simulation, column (3) isolates the effects of the revealed movements in the positions of China's export demand schedules. Movements in China's export demand schedules reflect a range of factors, encompassing: success in penetrating new markets and convincing foreign buyers to pay a quality premium for Chinese-sourced goods; general economic conditions in foreign markets; trade policy measures in China's export markets; and, supply chain sourcing decisions by private and public sector agents in China's export markets. Comparing the terms of trade outcomes in the two time periods in column (3), it is apparent that China faced a far less favourable international trading environment in the second period. This is consistent with characteristics of the second period, which covered the Covid-19 pandemic, U.S. tariffs on Chinese imports, and growing private and public sector unease in destination markets for Chinese goods about potential supply chain vulnerabilities.

How do shifts in the position of China's export demand schedules affect economic growth? In the first period (2012–2017), the substantial outward shift was favourable to China and stimulated exports, which increased by 21.6% (row 7). The outward shift in export demand—reflecting an increase in demand for Chinese goods at given prices—also improved China's terms of trade by 11.1% (row 19). This improvement in the terms of trade led to an expansion in the capital stock and, consequently, real GDP (4.8% and 3.4%, respectively; rows 14 and 1). Investment increased in response to the higher capital stock. With employment held fixed, the increase in capital stock raised the capital–labour (K/L) ratio, thereby increasing the marginal product of labour and, in turn, the real wage rate (6.5%, row 16).

The improvement in the terms of trade in column (3) also increases purchasing-power GNP relative to real GDP. This explains the stronger growth in real household consumption and government consumption (4.5%, row 4; 4.4%, row 6) compared with real GDP (3.4%, row 1). Given the relatively stronger growth in consumption and investment, the GDP identity implies a deterioration in the balance of trade, reflected in a real appreciation (14.1%, row 18) and a faster increase in imports (34.1%, row 8).

In summary, the substantial outward shift in China's export demand schedules over the period 2012–2017 contributed 3.4 percentage points to economic growth, primarily through increased capital accumulation. In contrast, the negligible change in export demand schedules during 2017–2022, reflecting the factors discussed above, resulted in a near-zero contribution to economic growth (0.1 percentage points; row 1).

5.2.4 Column 4: Population and labour force growth

Column 4 isolates the effects of changes in demographic and labour market factors over the two historical periods. While population growth was positive in both five-year periods, the rate of population growth declined, falling from 3% over 2012-17, to 0.8% over 2017-22 (row 9, column 4). Despite population growth being positive in both periods, employment growth was negative in both periods: employment declined by 0.3% over the five years 2012-17, and by 3.6% over 2017-22 (row 13). This was due to adverse demographic and labour market shifts. First, the share of the population aged 15 and over declined in both periods (row 10). Second, and more importantly, the effect of China's ageing population on the participation rate of this cohort became more manifest over the period, with the participation rate declining by 2.4% over the first period and a further 3.4% over the second period (row 11). The employment impact of these demographic shifts was compounded by adverse labour market conditions over both time periods, with the employment rate (one minus the unemployment rate) falling by 0.4% over 2012-17 and a further 0.8% over 2017-22 (row 12). Overall, the decline in employment damped economic growth in both periods (real GDP declines 0.4% in period one and 3.7% in period two (row 1). The damping effect is larger in the second period, reflecting the steeper employment decline in the second period.

5.2.5 Column 5: Cost-neutral change in lab/cap ratios by industry (twistlab)

The fifth column of Table 5 reports the effects of cost-neutral changes in the labour–capital ratio over the periods 2012–2017 and 2017–2022. This represents an additional source of technical change. The historical simulation in the previous section indicates a uniform decline in the labour–capital ratio across all industries of 10.7% and 11.9% in the two periods, respectively (column 2, Tables 3 and 4). This decline implies a shift away from labour towards greater capital intensity in production.

This shift helps explain the substantial increases in the capital stock and investment, which rise by 11.9% and 11.3% in the first period and 12.3% and 11.8% in the second period, respectively (rows 14 and 5, column 5, Table 5).

Holding employment and other technology factors constant and given an average capital share of 48% in primary factor inputs, the increase in capital translates into approximately a 6% increase in real GDP in both periods (row 1).

5.2.6 Columns 6 and 7: The level and composition of consumption spending

In the historical simulation, growth in real private and real public consumption are exogenously determined at their historically observed values. This allows the endogenous determination of two macro structural variables related to consumption: the ratio of private consumption to public consumption and the average propensity to consume (private and public) out of GNP. Columns (6) and (7) isolate the effects of movements in these two macro structural variables over both five-year periods in Table 5. The level and pattern of consumption at the macro level changed significantly between the two periods. The first period was characterised by a shift towards private over public consumption (compare rows

4 and 6 in column 6) and a rise in the propensity to consume (note the increase in both private and public consumption spending over 2012-17 in column 7). This is consistent with policy efforts to raise consumption spending and reduce reliance on public consumption over this period.

However, both structural shifts were reversed in the second period, with both household and government consumption in general falling by over 6 per cent over the period (column 7, 2017-22 outcome), and public consumption growing relative to private consumption (column 6, 2017-22 outcome). This reflects the greater uncertainty on the part of households during the second period, together with a rise in public consumption spending to support activities during the Covid-19 pandemic.

The increase in both private and government consumption, driven by a higher propensity to consume during 2012–2017, generates relatively modest effects on the capital stock, real GDP, and investment (1.4%, 0.9%, and 1.7%, respectively; rows 14, 1, and 5), reflecting the assumption of fixed employment and technology. However, the substantial expansion in consumption (C and G) implies, via the GDP identity, a deterioration in the balance of trade, facilitated by a real appreciation (2.9%, row 18, column 7). This real appreciation contributes to a strong increase in imports (5.4%, row 8), a contraction in exports (−6.7%, row 7), and an improvement in the terms of trade (2.2%, row 19).

By contrast, the decline in the propensity to consume during 2017–2022 leads to reductions in both private and government consumption, which in turn generate negative effects on the capital stock, real GDP, and investment (−1.5%, −1.0%, and −1.8%, respectively; rows 14, 1, and 5).

5.2.7 Columns 8 and 9: Investment /capital ratios and rates of return

Columns (8) and (9) identify the economic effects of structural shifts in capital markets uncovered during the historical simulation. First, in the historical simulation, the movement in economy-wide investment is determined exogenously, and an economy-wide shift in industry-specific investment / capital ratios is determined endogenously. Column (8) isolates the effects of the exogenous movement in investment/capital ratios over the two five-year periods. Second, column (9) isolates the effects of two sources of rate of return shifts that are endogenously calculated in the historical simulation, but imposed as exogenous shocks in the decomposition simulation.

First, we assume that there is some propensity for capital accumulation (decumulation) to attenuate divergences in initial industry specific rates of return that are high (low) relative to the economy-wide average rate of return. Second, we assume that industries that are experiencing comparatively high (low) rates of growth in capital relative to the average capital growth rate simultaneously experience a small rise (fall) in their required rate of return. Column (9) summarises the economic effects of both these factors in the decomposition simulation. The rate-of-return shifts reported in column (9) have only modest macroeconomic effects in both periods. The investment/capital ratio shifts are broadly similar across the two periods, although slightly larger in the second period. Accordingly, their macroeconomic impacts are somewhat stronger in the second period than in the first (column 8).

In the second period, investment increases by 5.5% (row 4, column 8, Table 5), while the capital stock rises by 0.9% (row 14), resulting in a 0.8% increase in real GDP (row 1). This pattern may reflect demand-stimulus measures aimed at supporting public and private investment during the more challenging economic conditions that characterised the second period.

5.2.8 Column 10: National savings momentum

Column 10 shows what would have happened to the economy of China had none of the shocks described by columns 1-9 occurred, and if only sufficient investment had been undertaken to keep physical capital at its initial level. Under these circumstances, net foreign liabilities fall sharply. The explanation for this fall is highlighted by the following stylised representation of the CHINAGEM net foreign liabilities equation:

$$\Delta \mathrm{NFL} = \tau \cdot \mathrm{K} \cdot \mathrm{D} - \tau \cdot \mathrm{GNP} \cdot (1 - \mathrm{APC})$$

where $\Delta \mathrm{NFL}$ is the change in net foreign liabilities over the study period, τ is the study period in years, K is the initial capital stock, D is the depreciation rate, GNP is gross national product, and APC is the propensity to consume out of GNP. Since base-period domestic savings ($\mathrm{GNP} \cdot (1 - \mathrm{APC})$) exceed depreciation investment ($\mathrm{K} \cdot \mathrm{D}$), in the absence of shocks to the economy (represented by columns 1 – 9), NFL must fall.

With NFL lower, real GNP is higher. With GNP higher, so too is private and public consumption spending. However, in column 10, the macro closure allows for little change in real GDP. This is clear from the decomposition closure: with technology, rates of return, tax rates and employment exogenous, there is little scope for the capital stock to change, and with employment and capital thus largely given, there is little scope for real GDP to change. With consumption higher but GDP rising only slightly, the balance of trade must move towards deficit. This requires an appreciation of the real exchange rate, which causes export volumes to contract and import volumes to rise.

5.3 Explaining China’s growth deceleration from 2017 -2022

We decompose the contributions of key economic factors to China’s economic growth over two periods: 2012–2017 and 2017–2022. Columns 2 and 3 of Table 6 identify the factors with relatively large effects on economic growth, based on the decomposition results reported in Table 5. Columns 4 and 5 present their respective contributions to real GDP growth in the first and second periods.

In the first period, only one factor—employment—exerts a negative effect on real GDP. Employment declined marginally (−0.26%), reducing real GDP by 0.4 percentage points. In contrast, during the second period (2017–2022), employment declined much more sharply (−3.56%), resulting in a 3.7 percentage point reduction in real GDP. This accelerated contraction in employment emerges as the most important factor driving the growth slowdown in the second period, consistent with demographic trends such as population ageing and a shrinking working-age population.

A second important factor is the change in the average propensity to consume. In the first period, an increase in the propensity to consume supported growth in both private and public consumption, contributing 0.9 percentage points to real GDP growth. By contrast, in the second period, the decline in the propensity to consume reduced consumption demand, lowering real GDP by 1.0 percentage point. This reversal highlights the weakening role of domestic demand in supporting economic growth.

Table 6: Contribution of economic factors to China's economic growth

Economic Factors	Changes of Economic Factors (%)		Contributions to GDP (%)	
	2012-17	***2017-2022***	2012-2017	***2017- 2022***
All factor augmented technology improvement	-16.16	***-12.98***	26.9	**19.6**
Labour / capital bias in technical change	-10.72	***-11.93***	6.0	**6.0**
Foreign demand (shift in the position of China's export demand schedules)	66.95	1.36	3.4	0.1
Average propensity to consume	4.10	***-4.70***	0.9	**-1.0**
Preference for imported goods	-36.71	***-13.75***	0.5	**0.1**
Investment/capital ratio	3.40	***4.14***	0.7	**0.8**
Employment	-0.26	***-3.56***	-0.4	**-3.7**

Source: CHINAGEM simulation results.

The contribution of all-factor augmenting technological change also declined markedly between the two periods. In 2012–2017, technological improvement contributed nearly 27 percentage points to real GDP growth, accounting for a substantial share of overall growth. However, in 2017–2022, its contribution fell to 19.6 percentage points, indicating a slowdown in productivity growth, which further dampened economic performance.

External demand conditions also played a crucial role. In the first period, a significant outward shift in China's export demand schedules contributed 3.4 percentage points to real GDP growth. In contrast, the shift in export demand was minimal in the second period, contributing only 0.1 percentage points. This reflects a less favourable external environment, including trade tensions, the COVID-19 pandemic, and increasing concerns over global supply chain resilience.

In addition, the preference for domestically produced goods weakened sharply in the second period compared with the first. While this factor still made a positive contribution to growth, its effect was considerably smaller, further contributing to the overall slowdown in GDP growth.

Overall, China's growth deceleration in 2017–2022 can be attributed to several interrelated factors: a faster decline in employment driven by demographic changes; a reversal in consumption behaviour; a slowdown in technological progress; a marked weakening in external demand conditions; and a reduced shift in preferences toward domestic goods. Together, these factors explain the significantly slower pace of economic growth observed in the period of 2017 to 2022.

6. Conclusions and policy implications

Using a decomposition simulation approach, this study applies the CHINAGEM model to analyse the drivers of China's economic growth over the periods 2012–2017 and 2017–2022. The results yield several key findings:

- Productivity improvement was the primary driver of China's economic growth in both periods, although the pace of productivity growth slowed in the second period.
- Declining employment dampened economic growth in both periods, with a substantially larger negative impact in 2017–2022, reflecting a sharper contraction in employment associated with accelerated population ageing.
- Strong growth in external demand (captured by shifts in export demand schedules) contributed significantly to economic growth in the first period, but this effect weakened markedly in the second period.
- A pronounced shift in preferences towards domestically produced goods supported growth in the first period, while this effect moderated considerably in the second period.
- The weaker growth in household consumption demand in the second period further contributed to the observed slowdown in economic growth.

Looking ahead, China's total population has begun to decline since 2022, and this trend is expected to intensify. The working-age population is projected to contract even more rapidly due to ongoing demographic ageing, implying continued downward pressure on employment.

In this context, the decomposition results highlight the critical role of sustained productivity growth in offsetting the adverse effects of demographic change. Policies that promote technological progress and innovation will be essential to maintaining long-term economic growth. In addition, shifting the focus from the quantity of labour to the quality of labour, through increased investment in human capital development, will be crucial for supporting productivity and ensuring sustainable economic growth in the face of a shrinking and ageing workforce.

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