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Original Paper

Corporate Transformation, Income Inequality, and Consumer Commodity Choice: The Economic Cycle in the Rise and Fall of Industries

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Abstract

In a multi-industry closed economy with constant productivity, this paper innovatively constructs an inter-industry transformation mechanism, and find the clustering behavior of enterprises transforming according to the industry prosperity will lead to the inter-industry evolution, which will lead to the fluctuation of the business cycle. We also find that the extreme boom/bust of a single industry will greatly increase the degree of income inequality, and when the industrial pattern composed of the development of different industries is in a balanced state, income inequality is at the lowest point of the economic cycle; At the same time, on the demand side of economic operation, we apply the heterogeneous commodity selection theory of utility maximization in classical economics to the household sector with two consumption preferences (high-grade and ordinary) for the first time, and finds that the implementation of diversified commodity basket subsidies for households in need of relief will promote the improvement of total social utility. This is the strong false evidence of the utilitarian view of social welfare; Finally, we study the government's attitude towards enterprise transformation, allowing the government to adjust the industrial structure of the economy by imposing macro-restrictions on the minimum number of companies in a single industry. It finds that enterprise transformation under excessive restrictions will lead to the failure of the market mechanism, making it impossible to rationally allocate production resources among industries, resulting in low GDP and low social utility. The extremely loose transformation supervision will have a profit impact on the high-end goods industry.

Keywords

Economic cycle, Enterprise transformation, Income inequality, Heterogeneous commodity selection, Social utility

1. Introduction

1.1 Background and Related Literature

It has always been a complicated and difficult work to explore the causes of economic fluctuations. For more than 100 years, scholars have made different explanations from the perspectives of changes in investment rate, changes in consumer demand, technological progress, changes in expectations, changes in economic system, and impacts of international economic factors. So that the possible mechanisms in the different dimensions of economic operation are as well understood as possible in empirical phenomena. However, both positivism and model regularism cannot be separated from the basic market principle of supply-demand in the framework of deconstructing economic fluctuations. Starting from the supply of enterprises, some scholars believe that technological progress is the fundamental factor that determines the productivity of enterprises and even supports the industry, and thus affects the total economic output. They inherited Schumpeter's entrepreneurial innovation spirit and made unremitting exploration in the aspects of technology selection, setting up heterogeneous workers and investing in innovation. Dosi et al. (2010) classified enterprises into upstream and downstream enterprises in the model, and constructed the depreciation renewal period and investment recovery period of production equipment of downstream enterprises to achieve economic growth under the circular interaction between consumer goods and capital goods enterprises. Ermanno et al. (2020), by introducing machine learning sales methods, found that enterprises can increase profits due to sales innovation, but it will lead to a decline in wage share and long-term growth rate. Dawid et al. (2019) examined and compared the impact of more frequent and substantial productivity-enhancing innovations in an enterprise modeling framework that incorporates endogenous technology selection and heterogeneous chemical worker work-learning. The results show that in both cases, the institutional change will lead to the increase of productivity heterogeneity and market concentration. Tian et al. (2020) demonstrate that education is expected to improve equality and reduce the Gini coefficient by increasing the average productivity and narrowing the productivity distribution width.

The other kind of scholars focus on the sustainability of supply. They highlight the problem of whether the cash flow is sufficient or not, which is determined by the credit status of enterprises, and then restricts the boundary conditions of expanding production. Lux (2016) proposed a stochastic model of the two-way credit network between banks and non-bank corporate sectors, and found that the overlap of corporate loans would bring common risk exposure to banks, thus exacerbating the lack of funds for enterprises. Rzeszutek (2021) combined behavioral finance to show that overconfident enterprises will lead to an increase in debt level, which will make the company vulnerable. Some other scholars studied the impact of capital supply on the total output of the real sector from the perspective of complementarity from the perspective of the financial system itself. Pei et al. (2021) built a mathematical model and proved that the impact on the largest banks and enterprises in terms of assets and entry can exacerbate the risk contagion between banks and enterprises. Alessia et al. (2023) applied Minsky's theory of financial fragility to analyze in an equilibrium model that banks' indulgence of

speculation and Ponzi enterprises would lead to the collapse of the economic system.

It is not difficult to see from the above research that the supply of enterprises is based on the two cornerstones of endogenous technical support and exogenous capital maintenance, but whether enterprises can grasp the demand of the market, they should focus on the financial situation of consumers, product preferences and commodity matching friction, which is the fundamental profit temptation of enterprises that determines whether the output can be digested or stimulate the further expansion of output. For households that play a role in the consumption of final products in the economy, most scholars in recent years start from the hypothesis of insufficient effective demand caused by income inequality in the macro economy, and emphasize the restraining effect of income inequality on the total consumption intention of the society. For example, Palagi et al. (2023) recently utilized the concept of natural growth rate in an intergenerational wealth inheritance model. Under the condition that the average household consumption tendency decreases with the increase of income, it is necessary to distribute income to more poor families to maintain the natural increase of social total demand. In terms of macro cyclical fluctuations brought about by income inequality, Dosi et al. (2013) believe that more unequal economies face more serious business cycle fluctuations, higher unemployment rate and greater possibility of crisis; Halter et al. (2014) empirically find that increasing inequality contributes to economic performance in the short term. But it will further reduce per capita GDP growth in the future. To further explain the formation of inequality mechanism and macro-output feedback, the results of Rolim et al. (2023) show the importance of the co-evolutionary interaction between workers' bargaining power and productivity growth to the dynamics of income inequality and its relationship with output. Takahashi et al. (2020), on the other hand, demonstrate from the rigidity of wages that economies with highly flexible nominal wages fail to meet stability conditions and produce a destabilizing positive feedback loop between real wage declines and aggregate demand.

In addition to the upper limit of income on consumption expenditure, on the demand side, it is not difficult for us to realize the preference impact of group cultural history, conspicuous consumption and conformity on product selection, which will shape the development of segmentation and scale differentiation between industries on a macro scale, and then affect the fluctuation of total output. The research on the field of heterogeneous commodity selection is rising gradually. Rengs et al. (2019) conducted simulation experiments from the perspective of evolutionary economics, showing that the co-evolutionary dynamics between consumption signals and firm specialization ultimately affect employment and consumer prices, and thus macroeconomic aggregate. Andreas et al. (2023) empirically demonstrated how consumption differences at the national level are related to cultural norms, GDP, and income inequality, and found that national spending hierarchies across countries are relatively similar for necessities, but increasingly unique for luxury goods.

At the same time, we should not ignore the regulating role of policies on the supply and demand relationship under the market mechanism, and the trade impact of the degree of international openness of an economy on production output. The results of Dweck et al. (2020) show that all scenarios that

impose tighter constraints on government spending show signs of self-defeating fiscal consolidation, including the impact on corporate indebtedness. On the other hand, unfettered countercyclical policies can prevent the contagion effects of external crises, thereby improving economic performance and reducing the likelihood of crises. According to Popoyan et al. (2017)'s model, the best policy combination to smooth output volatility is the triple Taylor rule focusing on output gap, inflation and credit growth, and the dual entity - financial policy combination combined with Basel III prudential supervision. Modeling by Rolim et al. (2022) found that shocks to the growth rate of external output (demand shock) and external inflation rate (price shock) both increase export growth and stimulate domestic output, but their effects on income distribution are opposite: positive external demand shocks lead to higher wage shares and lower income Gini coefficients. Positive external price shocks have the opposite effect.

In this regard, the causes of various aspects of macroeconomic fluctuations and the interaction effects between various economic sectors in the middle have been summarized as complete as possible in the supply and demand dimension of final commodities under the combination of previous studies, but until now, the specific cyclical mechanism has rarely been comprehensively modeled and analyzed in the micro - mesoscopic - macro. In terms of the supply of final commodities, the rise and fall of industries can be viewed from a dynamic perspective as the result of policy regulation, consumer choice, black swan events, etc. (rather than production capacity, technology, entrepreneurship) decisions, and the end of the intermediate industrial structure caused by these "intermediaries" will be the starting point of a new round of adjustment, more importantly, in the possible cycle, due to the turning and continuity of policies, the income determination of consumer preferences, and the scarcity and humaneness of investment hotspots, they are complementary to the target feedback brought by industry changes. For example, from the perspective of consumption choice: When a certain industry is prosperous, the labor force engaged in it may get a higher income, and their consumption basket will add more high-grade products, and then promote the prosperity of another industry, and the prosperous industry will attract new enterprises to enter, and the reduction of profits will in turn inhibit the income of workers (also consumers) in the corresponding industry. This in turn affects the macro aspects of consumption and supply and output. There are few studies on this kind of cross-sector circular feedback and its impact on economic fluctuations, especially in the most basic and direct dimension of vendor supply-consumer demand, which is to reveal the further dynamic basic mechanism of economic fluctuations. The purpose of this paper is to solve the problem of the circular mechanism of the interaction of the two forces in the basic and direct supply and demand relationship, which can also be regarded as a new combination of the utility preference theory and the macro-modeling of agents in classical economics.

1.2 Article Contributions

In a heterogeneous commodity selection model, this paper innovatively takes the consumption choice mechanism of utility maximization in classical theory as the demand force decision of micro

individuals, and realizes a total supply-total demand agent model by setting up the transformation of firms and industries motivated by the pursuit of higher profit rate on the supply side: The fluctuation of production capacity caused by the alternating rise and fall of the industry determines the cyclical fluctuation characteristics of the total economic output.

This raises a query to Schumpeter's consistent technology spirit: in the dual industry BC with fixed technology and different productivity, the equilibrium degree of industry development becomes the decisive factor affecting the fluctuation of economic output. In the specific experiment, this paper finds for the first time a new underlying mechanism affecting economic development - the fluctuation of production capacity led by industry transformation determines the fluctuation of economic output, and then forms the economic cycle. The specific mechanism is as follows:

When the B industry, as the main demand for production goods, prospers, it will increase the average productivity of the society due to the increase in the number of enterprises "lathes" and thus bring about a surge in GDP. When the flourishing industry is high-grade product C, its production capacity is limited by the lower demand ceiling of the public, and the other is limited by its own low productivity. Under both factors, a large number of enterprises pour into C, which will reduce the average productivity of the society and lead to the decline of GDP. This mechanism can also be vividly understood at the level of individual employment: an employed worker is brought in to produce a new product by a greedy, transformational business owner, and the change in productivity brings about the individual output gap, which in turn brings about macro fluctuations in GDP. In a larger dimension, it can be interpreted at the macro level of labor industry distribution: under the population size, when more workers are distributed in prosperous industries with higher productivity, the average productivity of society will be higher, and the GDP will be higher.

In terms of economic demand, compared with the lack of total demand caused by income inequality, which is concerned by the general literature, this paper believes that consumers of different income levels have heterogeneous demand choices for commodities, and for the first time introduces the commodity basket utility maximization in classical economics as their choice mechanism. In the emphasis on income-determined budget constraints, this paper assumes that high-income earners prefer high-grade consumer goods, while low-income earners prefer ordinary goods. The changes in income inequality determine the changes in the consumption sector's demand for the two types of heterogeneous goods. The specific mechanism of the dynamic impact of the comparative demand forces of the two types of commodities on economic output is as follows:

When the proportion of high-income people in the consumer increases, the market demand for high-grade C becomes stronger, and the supply of C industry is in short supply. Enterprise B observes that the prosperity of C industry is high (the total sales quota of C industry is larger than that of B industry), and begins to transform into C enterprises in large numbers; While the productivity of industry C is lower than that of industry B, the total output of the economy begins to decrease, and the social unemployment rate rises at the same time, the number of consumers with high incomes decreases,

the market demand for ordinary products B begins to increase, so the declining industry B begins to outstrip supply, finally it's total sales gradually exceed that of industry C; The C industry with weakened demand force observed that the total sales of the B industry exceeded it, and the C enterprise began to transform into the B enterprise in turn, which promoted the increase of the total output of the economy, the decrease of the social unemployment rate, the increase of consumers with high incomes, and the market demand for high-end products C began to become stronger, and so on.

1.3 Main Work

In order to link the micro consumer commodity choice with the transformation of enterprises and the rise and fall of industries in the Middle view, this paper first assumes that the family state is variable, consisting of five states: entrepreneur, banker, executive, worker, and unemployed, and they can switch to each other in the specific event of each step of the long run under certain conditions. Compared with the general agent literature containing class mobility, this paper does not focus on the job gap mechanism caused by the literacy determined by the educational experience of workers and executives, and believes that their employment and promotion are random, and the job distribution of the labor force will be randomly changed when enterprises adjust the labor force structure to meet the management ratio of production needs. In addition, in terms of the new entry of enterprises, this paper assumes that the wage earners have a fair opportunity to consider becoming new entrepreneurs, and the threshold of new entry is the cost threshold of the corresponding industry, which can be realized through household deposits and bank loans, and the type of enterprises in the industry is determined by the family preference under the influence of the comparison of industry prosperity. Such a class mobility mechanism lays a fair long-term basis for their wage income, and further provides growth support for consumption patterns under the influence of income.

In terms of demand for consumer goods, the consumption pattern determined by income determines commodity preference. This paper sets that unemployed people can only consume survival product A, and employed people can also consume ordinary product B and high-grade product C in addition to A fixed amount of A. Meanwhile, under the setting of expenditure threshold, their preference for BC is divided into two categories: ordinary consumer preference and high-grade consumer preference. Instead of focusing on the specific and possible internal structural forms of preference differences caused by Van Beuren effect and community imitation, this paper directly sets the two types of preferences as fixed parameters and uses the Douglas-form function to perform the extreme value optimal solution, so as to realize the BC choice decision of satisfying the utility maximization of the assumed rational economic man under the budget constraint boundary. Thus, the total demand for BC products in the household sector is obtained.

Another outstanding contribution of this paper is also on the supply side. This paper sets the two types of BC industries as open. Enterprises can consider the transformation according to their own operating conditions and industry prosperity, and they have to submit transformation loans to banks to achieve certain regulatory significance regardless of whether they have sufficient funds. In terms of enterprise

target output and commodity pricing, this paper also proposes the adaptive industry macro factor algorithm, which can ensure the boundary conditions of continuous interactive transformation of the industry.

Finally, in the bank's loan mechanism, this paper establishes the loan grade priority mechanism for the bank according to the principle of macro guidance and micro prudence. It is the difference between the required loan amount and the repayment ability obtained from the transformation of the loan demand submitted, the average EBIT of the target industry of the new enterprise in the first several periods, or the EBIT of the original enterprise submitted the original production plan in the first several periods. For the search of non-zero profits in the first several periods of the repayment ability of enterprises, it is very slow to go through the list in reverse order according to the traditional python method. In this paper, the profit time series of several enterprises is constructed as a matrix, and the operation of *numpy.matrix.flip* is used to achieve fast calculation. For calculating the bank's outstanding loan amount and default loan, under the same loan term n and uniform repayment of principal and interest each period, this paper only needs to apply the same method to the loan principal matrix for n periods in reverse order, and then multiply by $\frac{n-d}{n}(1 <= d <= n-1)or\frac{n-d}{n} \times (1+r_L)^n (1 <= d <= n-1)$ respectively in the time dimension.The loan principal assets and loan impairment losses (minus the amount that can be repaid on defaulted loans) are obtained for the current period.

2. Agent Model

2.1 Family Sector

For all households, at the beginning, the bank will pay interest on previous deposits $D_{i,t-1} * r_D$. For non-unemployed households, they will also estimate their non-financial income (including wages and corporate dividends). Based on the review of Strelkovskii et al. (2023), the average consumer will use adaptive learning and simple heuristics to form an expectation of future development based on the expected growth rate and inflation rate. In this paper, the expected income is set as follows:

$$\forall i \epsilon P_{t-1}, i \notin \text{unemployer}_{t-1}, \text{enonfi}_{i,t} =$$

$$\begin{cases} \text{nonfi}_{i,t-1} \times (1+\gamma_1 \times \text{inflation}_{t-1}) \times (1+\gamma_2 \times g_{t-1})), \text{if inflation}_{t-1} > 0 \text{ and } g_{t-1} > 0 \\ \text{nonfi}_{i,t-1} \text{else} \end{cases} \quad (1)$$

Where $\text{nonfi}_{i,t-1}$ refers to the actual non-financial income of three types of households that are still employed after enterprise bankruptcy in the previous period, inflation_{t-1}、g_{t-1} respectively refer to the rate of price change and economic growth in the previous period, and γ_1、γ_2 indicate households'sensitivity to these two macroeconomic situations, and are both less than 1. Households first consider the basic purchasing power of price changes, and second, if the economy is good, they will demand higher wage increases. The model also limits the expected non-financial income will not fall, it is at least the same as the actual non-financial income in the last period, which is conducive to the rigid law of wage decline. In the household state

set $P_{t-1} = \{firmer_{t-1}, worker_{t-1}, manager_{t-1}, banker_{t-1}, unemployer_{t-1}\}$, t-1 represents the household sector occupational state distribution after the bankruptcy of some companies in the profit settlement event at the end of the previous period.

For the convenience of subsequent records, when $i\epsilon\{worker_{t-1}, manager_{t-1}\}$, $enonfi_{i,t} = ew_{i,t}$, exists as the expected wage expwage, and when $i\epsilon\{firmer_{t-1}, banker_{t-1}\}$, $enonfi_{i,t} = eshare_{i,t}$, in the form of expected dividends.

In addition to non-financial income, working families (workers, executives) have their own retention wages, and they choose to leave when the wages offered by the firm are lower than their retention wages. And for the unemployed, they also have retention pay, which is used for re-employment consideration:

$$rw_{i,t} = \begin{cases} \max(bail\_m/(1-tax), ew_{i,t} \times \gamma_3), i\epsilon\{worker_{t-1}, manager_{t-1}\} \\ bail\_m \times \gamma_4/(1-tax), i\epsilon\{unemploy_{t-1}\} \end{cases} \quad (2)$$

The retained wages of employed persons depend on a certain percentage of their expected wages ($\gamma_3 < 1$) and the minimum amount of consumption after taking into account taxes; The unemployed, on the other hand, only consider whether the amount of wages after tax is several times the minimum consumption (γ_4>1). They all think that if the take-home pay is less than bail_m, then they would rather be unemployed/remain unemployed and receive benefits to consume basic goods A. tax refers to the unified tax.

After making income expectations, households begin to make plans for consumer spending. For non-unemployed households P, their expenditure plan takes into account two aspects (literature): one is the actual expenditure $act\_I_{i,t-1}$ in the previous period; the other is the current interest income, expected income and their own deposit withdrawal, which can be expressed as:

$$\forall i\epsilon P_{t-1}, i \notin unemployer_{t-1}, exp\_I_{i,t} = (1 - Inertia) \times (\xi\_y \times (enonfi_{i,t} + D_{i,t-1} \times r_D) + \xi\_w \times D_{i,t-1}) + Inertia \times act\_I_{i,t-1} \quad (3)$$

Inertia coefficient is the inertia of the last period of spending,ξ_y andξ_w are how households think about flow income and stock wealth respectively.If households find that their planned consumption cannot be met by the expected non-financial income and interest they have already earned, they will consider withdrawing their savings:

$$D\_change_1 = \begin{cases} \max(-D_{i,t-1}, \min(0, enonfi_{i,t} + D_{i,t-1} \times r_D - exp\_I_{i,t})), i\epsilon\{worker_{t1}, manager_{t1}, banker_{t1}\} \\ \max(-D_{i,t-1}, \min(0, D_{i,t-1} \times r_D - exp\_I_{i,t})), i\epsilon\{firmer_{t1}\} \end{cases} \quad (4)$$

And update the household deposit status D_{t-1} to $D_{t\square 1}$.The reason why entrepreneurs do not expect non-financial income in the deposit-taking scheme is that they receive a dividend after the sale of their business when the consumer goods market opens, whereas bankers receive a dividend after the bank makes a loan before the business is produced.

2.2 Firms

2.2.1 Target Output and Pricing

The target output of the two types of enterprises in the two industries of BC follows the mixed output determination model of the market mechanism and the macro situation mechanism, and industry A is the basic subsistence industry, and the total demand of the household sector for A has always been A constant, so category A enterprises do not consider macro factors. The target output of the three types of enterprises is assumed to be short-sighted, and they use the actual sales volume of the latest period as the memory anchor, so as to set their target output through the market mechanism (relative price and market share) and the common industry situation mechanism (macro factors) :

$$\text{aim\_Prod} = \begin{cases} \max(\text{yieldA}, \text{sales\_num}_{i,t-1} \times (1 + \alpha_1 \times (\text{sales\_share}_{i,t-1} - 1/\text{A\_firms}_{t-1}) + \\ \alpha_2 \times (1 - \text{relative\_price}_i))), i \in A_{t-1} \\ \max(\text{yieldB}, \text{sales\_num}_{i,t-1} \times (1 + \alpha_1 \times (\text{sales\_share}_{i,t-1} - 1/\text{B\_firms}_{t-1}) + \\ \alpha_2 \times (1 - \text{relative\_price}_i)) * (1 + FB_t)), i \in B_{t-1} \\ \max(\text{yieldC}, \text{sales\_num}_{i,t-1} \times (1 + \alpha_1 \times (\text{sales\_share}_{i,t-1} - 1/\text{C\_firms}_{t-1}) + \\ \alpha_2 \times (1 - \text{relative\_price}_i)) * (1 + FC_t)), i \in C_{t-1} \end{cases} \quad (5)$$

Where $\text{sales\_num}_{i,t-1}$ is the actual international sales volume of i enterprise in the previous period; $\text{sales\_share}_{i,t-1}$ is the sales market share of i enterprise in the previous period; A_{t-1}、B_{t-1}、C_{t-1} is the collection of enterprises in the three industries at the beginning of the current period.$*$ _firms refers to the total number of enterprises in the three industries that are selling in the previous period. relative_pricei is the relative price of the commodity of enterprise i with the average price of the corresponding industry in the previous period. The formula is:

$$\text{relative\_price}_i = P_{i,t-1}/\overline{P}_{id}, id = A_{t-1} \text{or} B_{t-1} \text{or} C_{t-1}, i \epsilon id \quad (6)$$

α_1 and α_2 indicate that the firm's share in the market mechanism and the relative price sensitivity of the product are both greater than 0 when setting the target output, while yield* represents the unit labor productivity of each of the three industries, which guarantees that the firm will hire at least one worker to produce. It can be seen that when the market share of an enterprise i is lower than the average share and the price is higher than the average unit price, the market factor must be negative, and the current output needs to be reduced on the basis of the actual sales volume of the previous period. The reverse is true.

BC two types of enterprises also consider the rise and fall of the macro industry, respectively with FBt, FCt linear expression, they are essentially the percentage of the number of sales with the number of supplies in the previous period:

$$F*_t = *\_sales_{t-1}/*\_supplies_{t-1} \quad (7)$$

When $\text{demand\_decline\_rate} < F*_t < \text{consume\_friction}, FB_t(FC_t)=0$;

When $0 <= F*_t <= \text{demand\_decline\_rate}, FB_t(FC_t) = f \times F*_t + h < 0$;

When $F*_t >= \text{consume\_friction}, FB_t(FC_t) = k \times F*_t + b > 0$.

consume_friction and demand_decline_rate represent the threshold of prosperity or decline of the industry respectively. When the sales-supply percentage is less than the lower threshold, the enterprise will have reason to believe that the demand side will decline, and this will not result in insufficient sales caused by commodity matching friction. Enterprises multiply the macro factor as a negative number on the right side of the market mechanism; When the percentage is higher than the upper threshold, the opposite is true, the enterprise believes that the industry commodity is in short supply, the macro factor is positive, and they will increase production (For enterprises whose sales volume was 0 in the previous period, their production plan for the current period is directly taken from the average sales volume of the previous period).

In this model of output determination, we should also note that an extreme situation occurs where the industry allows the creation of monopolies. We cap the output of a single enterprise in three industries:

$$* \_\text{max\_prod\_limit} = (10000 \times (1 - \text{unemploy}_{t-1}) - \text{firmer\_nums}_{t1} - \text{banker\_nums}_{t1}) \times 0.6 \times \text{yield} *$$

The implication of this formula is that a firm cannot hire more than 60% of the workforce of the employable wage group (executives, workers), thereby limiting the creation of monopolies. So the final aim output of any enterprise is:

$$\text{aim\_Prod}_{i,t} = \min(\text{aim\_P}_{i,t}, * \_\text{max\_prod\_limit}), i \in *, * = \text{AorBorC} \quad (8)$$

In terms of product pricing, the company follows the same mixed mechanism (except for the same A), the price of the previous period is the pricing anchor point, and the pricing factors P_indexB and P_indexC are introduced to limit the price to rise too fast.

$$\text{goods\_price} = \begin{cases} \min(\text{bail\_m}/10, \text{P}_{i,t-1} \times (1 + \alpha_3 \times (\text{sales\_share}_{i,t-1} - 1/\text{A\_firms}_{t-1}) + \alpha_4 \times (1 - \text{relative\_price}_i))), i \in A_1 \\ \text{P}_{i,t-1} \times (1 + \alpha_3 \times (\text{sales\_share}_{i,t-1} - 1/\text{B\_firms}_{t-1}) + \alpha_4 \times (1 - \text{relative\_price}_i)) * (1 + \text{FB}_t/\text{P\_indexB}), i \in B_1 \\ \text{P}_{i,t-1} \times (1 + \alpha_3 \times (\text{sales\_share}_{i,t-1} - 1/\text{C\_firms}_{t-1}) + \alpha_4 \times (1 - \text{relative\_price}_i)) * (1 + \text{FC}_t/\text{P\_indexC}), i \in C_1 \end{cases} \quad (9)$$

At the same time, the α1 and α2 are replaced by α3 and α4, indicating the sensitivity of the enterprise to the two types of market factors in the price setting. It should be noted that the price of Class A goods set by Class A enterprises cannot exceed the maximum price allowed by the benefit, and 10 indicates the fixed consumption of Class A products by households.

In this section we also get the rules for the central bank's current bailout:

$$\text{bail\_m} = \max(\text{max\_PA}_{t-1} \times 10 \times \text{inflation}_{t-1} \times 1.2 \ , \ \text{max\_PA}_{t-1} \times 10 \times 1.2) \quad (10)$$

2.2.2 Wages and Dismissal

2.2.2.1 Wages and Employees' Active Retention

The wages of company j are based on two aspects: one is the actual wages paid in the previous period; the other is based on the same spirit of Rolim et al. (2023), which holds that the company will consider

the expected wages of workers and executives, and the business owner will extract the expected wages according to a certain proportion and obtain the arithmetic average. In this process, in order to achieve their common wage expectations, the working class will use their bargaining power κ to negotiate with the company, and in order to control labor costs, the company will reduce the bargaining power of the working class according to the available mobile labor force (literature), that is, the proportion of the number of people waiting for employment. The final salary of Company j in this period is:

$$\mathrm{wage_{j,t}} = \max(\mathrm{exp_{j,t}} \times (1 - \kappa \times \mathrm{unemploy_{t-1}}) + \kappa \times \mathrm{unemploy_{t-1}} \times \mathrm{wage_{j,t-1}}, \mathrm{bail\_m}/(1 - \mathrm{tax})) \quad (11)$$

$exp_{j,t}$ is the average of the wages of some executives in enterprise j are converted into the expected wages of workers according to the labour_ratio (labour_ratio, the number of workers/executives, or the number of people in charge of a senior manager, which is a constant and applicable to any enterprise) and the average of the wages of some workers; $wage_{j,t-1}$ is the actual wages of enterprise j in the previous period; Enterprise wages, after deducting taxes, should also not be lower than $bail\_m$.

After company j gives the current salary, the employed executives and workers will take the initiative to decide whether to stay or go according to their retained salary $\mathrm{rw_{i,t}}$, and the employment status of workers and executives in company j will change for the first time, $\mathrm{pros\_w}_{j,t-1}$ and $\mathrm{pros\_m}_{j,t-1}$ *change into* $\mathrm{pros\_w}_{j,t,1}$ and $\mathrm{pros\_m}_{j,t,1}$. And the employee who leaves becomes unemployed, lead to the first change in family occupational status P_{t-1} and then recorded as $\mathrm{P}_{t,1}$.

2.2.2.2 Class Mobility of Employees

Among the remaining employees, after accepting the salary of the enterprise, they begin to consider whether they can become new B or C entrepreneurs, and the mechanism here is the core channel of class mobility in this paper: Wage family i compares its deposit state $\mathrm{D_{i,t,1}}$ after making consumption decisions with the entry and exit cost threshold low_TC of the BC industry, selects a new type of enterprise, and expects to produce according to the average enterprise size of the corresponding industry in the previous period.

① When the deposit of household i is only greater than the entry threshold of a class of industries, household i only considers becoming a class of enterprises:

$$\text{if } \min(\mathrm{TC^{low}_{t-1,B}}, \mathrm{TC^{low}_{t-1,C}}) < \mathrm{D_{i,t,1}} < \max(\mathrm{TC^{low}_{t-1,B}}, \mathrm{TC^{low}_{t-1,C}}), \mathrm{enter\_id} = \mathrm{B/C} \quad (12)$$

Further, if the deposit of family i is directly greater than the average cost of the id industry $\mathrm{TC^{av}_{t-1,id}}$, then family i does not need a bank loan, directly becomes a new entrepreneur, changes the family occupation status P and the employment status of the company j pros_*, and records the direct collection of new entrepreneurs direct_B/direct_C.If the deposit of i does not reach the cost of the average id industry in the previous period, households can only become entrepreneurs through loans, and the willingness to borrow depends on the gap between the average production cost, which is assumed to be evenly distributed as follows:

$$\mathrm{P(new\_id)} = (\mathrm{D_{i,t,1}} - \mathrm{TC^{low}_{t-1,id}})/(\mathrm{TC^{av}_{t-1,id}} - \mathrm{TC^{low}_{t-1,id}}) \quad (13)$$

In the program, if the random floating point number of (0,1) is less than$\mathrm{P(new_id)}$, then family i

decides to become an id entrepreneur and submits a loan with $\{i: TC^{av}_{t-1,id} - D_{i,t,1}\}$ to the bank loan application with $loans\_to\_id(id = B/C)$.

② When the deposits of household i are both greater than the entry thresholds of the two industries, the household chooses one industry in the B and C industries to enter, and the preference of the selection depends on the proportion of the sales amount of the two industries in the previous period. Take the example of preference for B:

$$Pre\_B = B\_sales\_m_{t-1}/(B\_sales\_m_{t-1} + C\_sales\_m_{t-1}) \quad (14)$$

Preference here is essentially the probability of choosing to enter a certain industry. When family i decides to enter a certain industry, the subsequent mechanism is the same as ①.

③ If the number of households with direct new entrepreneurs plus the number of BCfirms at the beginning of the current period is greater than the maximum number of BCfirms legally allowed by the government, randomly select more than part of the number of direct new firms, reverse the change of their savings, occupation and employment status, and empty out the indirect loans of households with new enterprises. Reverse changes in its deposits; If the direct new entrepreneur is less than the ceiling gap, then the loan with the new gap number is randomly selected from the submitted loan, the unselected loan is deleted, and the corresponding deposit change of its household id is reversed.

2.2.2.3 Passive Dismissal of Employees

In order to meet the requirements of target output, Enterprise j will further lay off the employees who remain and exclude the new entrepreneurs directly. Then, if the remaining employees cannot meet the labor ratio, such as the number of workers /LR> the number of executives, or the number of executives is too large, then j will randomly exchange employees in the two groups, while meeting the labor ratio, expand the workers as much as possible, so as to increase the output of workers' direct production decisions. Finally, if the enterprise finds that its own funds cannot meet the total salary of the remaining employees, the enterprise will continue to lay off workers (give priority to laying off workers to ensure the stability of the labor ratio) until its own funds can meet the total salary.

Finally, we get the employment status $pros\_w_{j,t,1}$、$pros\_m_{j,t,1}$ of enterprise j before it enters the employment market. And family occupational status $P_{t,1} = \{firmer_{t,1}, worker_{t,1}, manager_{t,1}, banker_{t,1}, unemployer_{t,1}\}$. As well as the loan loans_to_B and loans_to_C submitted by new entrepreneurs prepared by the household, and the deposit status $D_{t,2}$ after the household withdraw.

2.2.3 Transformation of BC Enterprises

For enterprises in a specific industry, in addition to making the original production plan, they will also observe the rise and fall of the industry, and it is short-sighted: if the total sales of the other industry in the previous period is greater than the total sales of their own industry, then they have the motivation to transform, and the size of the motivation is negatively related to their net profit ranking in their own industry.

For a B company j, the motivations for it to consider transformation are:

$$\text{if } B\_sales\_m_{t-1} < C\_sales\_m_{t-1}: Motives(j\_trans) = netprofit\_level_j / prob\_rate \quad (15)$$

Among them, $netprofit\_level_j$ excludes the enterprises which stay in min_nums top netprofit rankings group to prevent the situation of the original industry being empty; While $prob\_rate$ is also a constant, it avoids excessive motivation for transformation.

Mindful Motives(j_trans) is only a prerequisite for transformation, and Firm j will then substantially consider whether its own capital can support the human cost of transformation. Like new entrepreneurs, companies motivated to transform consider the production cost threshold to enter, as well as the labor cost to achieve average production. If j's own funds are greater than the threshold cost of transformation, then the gap from the average cost is the position of the transformation loan; If j's own funds cannot reach the threshold cost of transformation, then the owner of j will take out his own household savings to meet the threshold needs. Once it has reached the threshold, the owner of j will also submit a gap loan between the average cost and the threshold value to reduce the pressure on the owner of j's savings. It can be expressed by the following formula:

$$①\text{if } RP_{t-1,j} + F\_D_{t-1,j} \times r_D > TC^{low}_{t-1,C}: trans\_loans = \{j: TC^{av}_{t-1,C} - TC^{low}_{t-1,C}\} \quad (16)$$

$$②\text{if } RP_{t-1,j} + F\_D_{t-1,j} \times r_D < TC^{low}_{t-1,C} \text{ and } RP_{t-1,j} + (F\_D_{t-1,j} + 1) \times r_D > TC^{low}_{t-1,C}:$$
$$trans\_loans = \{j: TC^{av}_{t-1,C} - TC^{low}_{t-1,C}\}, F\_D\_change\_1_j = \{i: TC^{low}_{t-1,C} - (RP_{t-1,j} + F\_D_{t-1,j} \times r_D)\} \quad (17)$$

$$③\text{if } RP_{t-1,j} + (F\_D_{t-1,j} + 1) \times r_D < TC^{low}_{t-1,C} \text{ and } RP_{t-1,j} + (F\_D_{t-1,j} + 1) \times r_D + D_{i,t,2} > TC^{low}_{t-1,C}:$$
$$trans\_loans = \{j: TC^{av}_{t-1,C} - TC^{low}_{t-1,C}\}, F\_D\_change\_1_j = \{i: F\_D_{t-1,j})\}, D_{j,t,3} = D_{j,t,2} - (TC^{low}_{t-1,C} -$$
$$RP_{t-1,j} + (F\_D_{t-1,j} + 1) \times r_D) \quad (18)$$

①②③represent three types of transformation boundary cases in which enterprise j does not rely on enterprise deposit principal $F\_D_{t-1,j}$, depends on enterprise deposit, and also needs to rely on the owner's family deposit $D_{i,t,2}$ to achieve transformation, where $RP_{t-1,j}$ is the retained profits of the previous period of j.And get deposit withdrawal and loan submission dictionaries $trans\_loans$、$F\_D\_change\_1_j$.

The same is true for the transformation of enterprise C into enterprise B. Finally, we get the transformation loan dictionary $trans\_loans$ of enterprises, the change dictionary F_D_change_1 of enterprises withdrawing their own company deposits, and the household deposit status $D_{t,3}$ after the owners withdraw their own deposits.

2.2.4 Final Deposit Withdrawal and Original Production Loan Submission of Three Types of Enterprises

When the company's own funds cannot cover the total salary of the target labor force, it will consider submitting a loan application for the original production plan. For a company j that has also submitted a transformation loan, it will submit both types of loans to the bank for its consideration. The only thing that enterprise j needs to compare is the size of the enterprise deposits to be withdrawn in the transformation plan and the enterprise deposits to be withdrawn in the original production plan, and take the larger value as the expenditure of the enterprise deposits in the current period.

First obtain the loan and deposit withdrawals submitted in the original plan. Looking back at the target yield aim_Prod, for a company j in industry B, its target number of workers $\text{aim\_worker}_j = \text{int}(\text{aim\_Prod}_j/\text{yield\_B}) + 1$, The target total salary is $\text{aim\_towage}_j = \text{wage}_{j,t} \times \text{aim\_worker}_j + (\text{int}(\text{aim\_worker}_j/\text{LR}) + 1) \times \text{wage}_{j,t} \times \text{WR}$.WR is the ratio of executive pay to worker pay and is a constant that applies to any industry.

If j retained profit $\text{RP}_{t-1,j}$ and initial interest income $\text{F\_D}_{t-1,j} \times \text{r}_D$ cannot satisfy aim_towage_j, then the enterprise decides to withdraw deposits. $\text{F\_D\_originchange\_1}_j = \text{aim\_towage}_j - (\text{RP}_{t-1,j} + \text{F\_D}_{t-1,j} \times \text{r}_D)$, and enterprise j will compare the deposit withdrawal F_D_change_1_j required by the transformation with it. The final deposit extraction is $\text{F\_D\_outflow\_1}_j = \max(\text{F\_D\_originchange\_1}_j, \text{F\_D\_change\_1}_j)$, if its own funds cannot meet the enterprise production plan will be submitted to the original loan $origin\_loans_j = \text{aim\_towage}_j - (\text{RP}_{t-1,j} + (\text{F\_D}_{t-1,j} + 1) \times \text{r}_D)$

Finally, we get the change of enterprise deposit F_D_outflow_1, the change of current enterprise deposit status $\text{F\_D}_{t,1}$, the original production loan $origin\_loans$.

2.3 Bank

2.3.1 Income of Loan Principal and Interest and Update of Loan Matrix

This model does not introduce the balance sheet equation because it assumes that the only bank has no equity capital. The bank's business consists of depositors' deposits, the two basic businesses of transformation, existing production and loans to new entrepreneurs, as well as reserves deposited with the central bank and its own prepayment liabilities to the central bank.

At the beginning of each period, the Bank receives repayment of the outstanding loan items TP_t and calculates the outstanding balance of the outstanding loan items $\text{TUP}_{t,1}$.For enterprises, they pay the principal and interest of the loan at the end of the previous period when the profit is calculated, and pay the bank at the beginning of the current period. If their profit after interest is negative, it means that they cannot repay the bank's loan principal and interest in full and fall into default, the bank will offset their deposits by the same amount, if the offset is not enough, the enterprise will go bankrupt. In any case, the payments received by banks for default are not enough, as $\text{defaultpays}_{t,1}$. For those that have repaid in full, the amount they have repaid is $\text{enoughpays}_{t,1}$. Then the loan principal and interest and repayment received by the bank at the beginning of the period are:

$$TP_t = defaultpays_{t,1} + enoughpays_{t,1} \quad (19)$$

Further bank loans will update matrix $\text{loans\_matrix}_{t-1}$, will be deleted row of bankrupt enterprise get $\text{loans\_matrix}_{t,1}$, while for repaid enterprises remain the same.The underlying meaning here is that the remaining uncollected money of the bankrupt enterprise is recorded as bad debt disposal, and the liability of the bankrupt business owner is no longer pursued.

The loan matrix is a book that records the initial loan amount of each period, which is listed as the time dimension, and one column is added after each period. If the enterprise does not get the loan, 0 is added at [i, t], and the amount is recorded as scheduled for the enterprise that gets the loan. The time

dimension of [T-N +1, T-1] of the loan matrix is taken to calculate the loan amount at the beginning of the t period, and the sum of the element values corresponding to the row is selected in a certain proportion.n is the fixed period of repayment of a loan, which is the same for any business. Take a row of elements:

For an enterprise j, if it is in t-n+1,t-n+2,...,t-1, the money is borrowed in each installment of the t-1 period includes$loans_{t-n+1,j}...loans_{t-1,j}$. Then its unpaid principal amount for the current period is $\sum_{d=1}^{n-1} loans_{t-d,j} \times \frac{n-d}{n}$.

By extending a single bank to all lines, the unprincipal loan balance of the bank at the beginning of the current period can be obtained as follows:

$$TUP_{t,1} = \sum_{d=1}^{n-1} loans\_matrix_{t,1}[:, \mathrm{t-d}] \times \frac{n-d}{n} \quad (20)$$

Now the bank's principal and interest loan repayment rules are clear, in order to obtain the $enoughpays_{t,1}$ analytical formula is:

$$enoughpays_{t,1} = sum(loans\_matrix_{t,1}[:, \mathrm{t-n+1:t-1}]) \times \frac{(1+r_L)^n}{n} \quad (21)$$

This formula indicates that the repayment of a loan is equal each period, and the total repayment is calculated by compounding the initial amount of the loan at the time of borrowing, the loan interest rate is r_L, and the loan term is n.

2.3.2 Consideration of Interest Payment and Borrowing Advance Payment

Stored in a central bank reserves there also brought interest income for the bank $r_R \times R_{t-1}$, the bank at the beginning of revenues have $r_R \times R_{t-1} + TP_t$.

The bank now pays interest on deposits $\mathrm{r_D \times TD_{t-1}}$ and advances interest $\mathrm{r_A \times A_{t-1}}$ to its depositors and central bank: ① when the bank's total income is insufficient, it draws on the reserves it places with the central bank; ② If the reserve reaches the legal reserve floor $\mathrm{R \times TD_{t-1}}$ (R is the legal reserve ratio) required by the depositor, the bank will borrow an advance payment from the central bank ΔA to pay the interest; ③ If ΔA is greater than bail_A, the maximum relief capacity that the central bank can pay, then the bank will fail and the economy will restart. This process is now described in terms of boundary conditions:

①if $r_R \times R_{t-1} + TP_t - r_D \times TD_{t-1} - r_A \times A_{t-1} >= 0$:

$$R_{t,1} = R_{t-1} + r_R \times R_{t-1} + TP_t - r_D \times TD_{t-1} - r_A \times A_{t-1}, \mathrm{A_{t,1}} = A_{t-1} \quad (22)$$

② if $r_R \times R_{t-1} + TP_t - r_D \times TD_{t-1} - r_A \times A_{t-1} < 0\ and\ r_R \times R_{t-1} + TP_t + (R_{t-1} - R \times TD_{t-1}) - r_D \times TD_{t-1} - r_A \times A_{t-1} >= 0$:

$$R_{t,1} = R_{t-1} - (r_D \times TD_{t-1} + r_A \times A_{t-1} - r_R \times R_{t-1} - TP_t), \mathrm{A_{t,1}} = A_{t-1} \quad (23)$$

③ if $r_R \times R_{t-1} + TP_t + (R_{t-1} - R \times TD_{t-1}) - r_D \times TD_{t-1} - r_A \times A_{t-1} < 0\ and r_R \times R_{t-1} + TP_t + (R_{t-1} - R \times TD_{t-1}) + \mathrm{bail\_A} - r_D \times TD_{t-1} - r_A \times A_{t-1} > 0$:

$$R_{t,1} = R \times TD_{t-1}, \mathrm{bail\_A} = \mathrm{bail\_A} - (r_D \times TD_{t-1} - r_A \times A_{t-1} - r_R \times R_{t-1} - TP_t - (R_{t-1} - R \times TD_{t-1})), \mathrm{A_{t,1}} = A_{t-1} + (r_D \times TD_{t-1} - r_A \times A_{t-1} - r_R \times R_{t-1} - TP_t - (R_{t-1} - R \times TD_{t-1})) \quad (24)$$

2.3.3 Payment of Depositor's Deposit Withdrawal

If the bank does not go bankrupt in the interest payment stage, then it will face the liquidity pressure of consumption withdrawal, new enterprise withdrawal, and transformation withdrawal, according to the formula above:

$$\triangle \mathrm{TD} = \mathrm{D\_change}_1 + (\mathrm{D}_{t,3} - \mathrm{D}_{t,1}) - \mathrm{F\_D\_outflow\_1} \quad (25)$$

According to 2.3.2, if the current income of the bank can pay the interest expense, the remaining part is deposited in the reserve, while in other cases, it can only consider whether the reserve can continue to be withdrawn, and then continue to borrow advances from the central bank. In turn, the withdrawal of depositors will lead to a reduction in the legal reserves required for deposits. This is reduced to a unique boundary case:

if $R_{t,1} - (TD_{t-1} + \triangle \mathrm{TD}) \times R >= -\triangle \mathrm{TD}$:

$$R_{t,2} = R_{t,1} + \triangle \mathrm{TD}, TD_{t,1} = TD_{t-1} + \triangle \mathrm{TD}, \mathrm{A}_{t,2} = \mathrm{A}_{t,1} \quad (26)$$

elif $R_{t,1} - (TD_{t-1} + \triangle \mathrm{TD}) \times R + \mathrm{bail\_A} >= -\triangle \mathrm{TD}$:

$$R_{t,2} = (TD_{t-1} + \triangle \mathrm{TD}) \times R, TD_{t,1} = TD_{t-1} + \triangle \mathrm{TD}, \mathrm{A}_{t,2} = \mathrm{A}_{t,1} + (-\triangle \mathrm{TD} - (R_{t,1} - (TD_{t-1} + \triangle \mathrm{TD}) \times R)) \quad (27)$$

If the central bank cannot make sufficient advances, the bank is insolvent at this point.

2.3.4 Newloans

As can be seen from 2.3.2 and 2.3.3, if the bank borrows advances in either event, the bank will have no surplus liquidity to pay dividends and carry out new loan business in the current period. So we can accurately get the surplus liquidity from the unique boundary of 3.3 as follows:

$$\mathrm{RC} = R_{t,2} - TD_{t,1} \times R \quad (28)$$

If$\mathrm{RC} > 0$, the bank pays a dividend, the ratio is ψ_2, and the bankers receive an after-tax dividend of $\mathrm{RC} \times \psi_2 \times (1 - tax)$. The remaining liquidity is also $(1 - \psi_2) \times RC$. The bank then uses this for possible loan issuance.

Three types of loans are reviewed: loans_to_B, loans_to_C loans submitted by working class indirect new entrepreneurs; trans_loans submitted by BC enterprises for mutual transformation; The loan submitted by ABC enterprise for its original production plan $origin\_loans$.The bank gives each loan a ranking rank value by judging the repayment ability of the enterprise, placing them in the list from the highest Draw in turn until the total amount is about to be greater than $(1 - \psi_2) \times RC$. The process of issuing loans is not complicated, the key lies in the bank's judgment on the repayment ability of each loan enterprise:

① For the loan of the new enterprise B of the working family i, the bank's investigation of its repayment ability is as follows:

$$loans\_level_i = \sum_d^4 av\_EBIT_{t-d,B} - loans_i \times \frac{(1+r_L)^n}{n} \quad (29)$$

The left formula is the loan grade, the right one $av\_EBIT_{t-d,B}$ is the average EBIT of industry B in the previous d period, and $loans_i$ is the amount of loan demand submitted by the i family for promotion

of enterprise B. This kind of investigation mechanism reflects the concern of banks on the prosperity of the industry. Banks pay attention to the average EBIT profit in the first four periods of the industry, which is as close as possible to the macro situation of the average production, which is conducive to the control of lending risks. The same applies to the loan grade of newly promoted C enterprises.

② For the loan grade judgment formula of enterprises in transformation, it is necessary to add the reconstruction items of untasted loans of the original enterprises in addition to the average EBIT of the transferred industries. For j, a transformation enterprise that has transferred into the C industry, its loan grades are:

$$loans\_level_j = \sum_d^4 av\_EBIT_{t-d,C} - (loans_j + UP_j) \times \frac{(1+r_L)^n}{n} \quad (30)$$

$UP_j = \sum_{d=1}^{n-1} loans_{j,t-d} \times \frac{n-d}{n}$ is j enterprise remaining outstanding issue of loan principal of the sum of the parts, the bank as a new loan principal to inspect after transformation of the enterprise's ability to bear all debt before j. The same applies to the loan grade of a B corporation.

③For the production plan of the original enterprise, the bank needs to independently investigate the operation of the first four periods. In order to avoid the cumbersome calculation of the repayment ability of new loans due to historical outstanding loans under EBIT, this model chooses the EBIT profit after interest and tax of enterprise j as the measurement index, which can be expressed as follows:

$$loans\_level_j = \sum_d^4 before\_tax\_profit_{t-d,B} - loans_j \times \frac{(1+r_L)^n}{n} \quad (31)$$

④For enterprises that submit loans for transformation and original production plans at the same time, the bank will randomly delete a class of loans and put them in the grade list.

Under the premise of not exceeding the maximum loan capacity of the bank, the enterprises in the final three types of loans have obtained the full loan satisfaction according to the repayment level, and are recorded as new_B、new_C、gain_origin_firms. Finally, when the total loan demand amount of the current period $TLD_t < (1-\psi_2) \times RC$, the bank will also pay the advance payment, which is:

$$A_{t,3} = A_{t,2} - \max(0, ((1-\psi_2) \times RC - TLD_t)) \quad (32)$$

2.4 Labour Market

The Labour market is open only at certain times per period, and all employment contracts apply where the firm's wages are no less than the retained wages of its employees. In other words, every time the labor match is performed, all non-enterprise (bank) owners will not be fully matched again, which is conducive to reducing the algorithm complexity.

Note that after the bank ends the loan, for the new entrepreneur i, if he is in the company's employment status $pros\_w_{t,1}$、$pros\_m_{t,1}$, he should be deleted from it and added to the enterprise id, we get the company's employment status here is$pros_w_{t,2}$、$pros\_m_{t,2}$; At the same time, the government pays close attention to the situation of survivable industry A. If the number of class A enterprises in the current period is lower than the initial number set by the government, the government will extract the

gap number from the unemployed as the new A business owners, and give the support fund of the average cost of industry A in the previous period (not to be repaid), which is new_A. Second update occupational status, the family has $P_{t,2} = \{firmer_{t,2}, worker_{t,2}, manager_{t,2}, banker_{t,2}, unemployer_{t,2}\}$ Looking back at aim_worker_j, the target number of workers in enterprise j in 2.4, we can get that the target total labor force is $aim\_labour_j = aim\_worker_j + int(aim\_worker_j/LR) + 1$. If the total labor force of $pros\_w_{j,t,2}$、$pros\_m_{j,t,2}$ is lower than aim_labour_j in the current employment state of j, then j will enter the labor market to fill the labor force gap under the target production. Of course, for those enterprises that have submitted loan applications but have not received loans, their original production plans cannot be satisfied, and the number of people they enter the labor market and employ depends on whether they still have their own funds and the size of the funds.

For the successful new enterprises and transformation enterprises new_B and new_C, as well as the government-supported new_A, their target labor force is the average labor force $av_labour_{id,t-1}$of the corresponding industry in the previous period, which is also the labor gap of new enterprises.And the transformation of enterprise labor gap is $av\_labour_{id,t-1} - |pros\_w_{j,t,2}| - |pros\_m_{j,t,2}|$; Their wages are expressed by the average wage of the corresponding industry in the previous period $av\_wage_{id,t-1}$. Record all enterprises to enter the labor market with their labor gap as the dictionary labour_gap, and record their id and wages as the dictionary wage_dict. The specific labor matching mechanism is an attractive model of wage relative price. Inspired by the matching model of Takahashi et al. (2020), the python process is as follows:

①$unemployer_{t,2}$ of $P_{t,2}$ are randomly scrambled.

② Traversal $unemployer_{t.2}$.

③For an unemployed family i, he will randomly select a firm from thewage_dict with a certain probability and compare it with his retention salary.The probability $P(i,j) = \frac{wage\_dict}{sum(list(wage\_dict.values()))}$ that any firm j is matched by family i, divided into the total wages of firms in the current labor market.

If rw_i <= wage_dict, that is, the retained wage of family i is lower than the quoted wage of enterprise j, then family i selects enterprise j, and the labor gap of enterprise j is reduced by 1, denoted as $labour\_gap -= 1$.Meanwhile, delete family i from $unemployer_{t,2}$;Ifrw_i > wage_dict, then skip the i family and continue with ②.

④ If labour_gap==0, delete the key-value pair of enterprise j from wage_dict and continue to execute ②.

⑤ If the last family in ② hires a servant,$sum(list(labour\_gap.values()))$ of the total number of employees required by the enterprise is still greater than 0, and $unemployer_{t,2}$ is still not empty, then continue to carry out the next round of recruitment, return to ①, and record the number of recruitment rounds nums; If $sum(list(labour\_gap.values()))$==0 or len($unemployer_{t,2}$)==0, then the program stops.

⑥ When the number of recruitment rounds nums>=Circle, the program stops.

The process of labor force matching is bound to have friction. The program test shows that when all 10,000 households are used for employment matching, the friction can be basically eliminated when the number of recruitment rounds is Circle=10.In addition, enterprises should also randomly divide the hired labor force according to the number of workers and executives in $\text{pros\_w}_{j,t,2}$ *and* $\text{pros\_m}_{j,t,2}$ according to the labor ratio LR, which also reflects the luck of "class mobility".

When the labor market finally closed, Enterprise employment status with the third time is $\text{pros\_w}_{t,3}$ and $\text{pros\_m}_{t,3}$, family job status is $P_{t,3} = \{\text{firmer}_{t,3}, \text{worker}_{t,3}, \text{manager}_{t,3}, \text{banker}_{t,3}, \text{unemployer}_{t,3}\}$. After the enterprise pays wages, workers start production, senior executives supervise production, and enterprise j gets the final output:

$$Prod_{j,t} = yield_{id} \times \left|\text{pros\_w}_{j,t,3}\right| \quad (33)$$

For A firms, the government supervises that their total output reaches the fixed aggregate demand needed by everyone in the economy; if not, the government introduces an overtime mechanism to allow the firm to continue producing. The government randomly selects an enterprise from industry A to work overtime, and the productivity is linearly positively correlated with the overtime pay, which is initially several times of the wages of the selected enterprises and linearly increases with the increase of the enterprises working overtime. When all the enterprises in industry A have worked overtime once again, but the total output is still not enough for everyone to survive, the economy stops.

2.5 Consumer Goods Market

2.5.1 Consumer Goods Selection Model

All households consume to obtain survival goods A, and pleasure goods B and C. For families with different incomes, the amount of remaining consumption after they consume survival product A determines their respective attitudes toward ordinary product B and high-end product C. This model assumes that there are three types of household consumption patterns. The first type is that the income is not enough to buy A or unemployed people, they need government relief, they only buy class A products; The second category is the families whose remaining amount after purchasing the fixed number of class A products is lower than the threshold threshold_I, and their preference for class B products is much stronger than class C products. The third group is just the opposite of the second. They have more money and prefer the C products over the B products.

Then we introduce the Douglas-style consumption choice utility model to the families that can consume hedonic goods. For ordinary or high-end consumers, their utility index for each type of product is consistent, respectively:

$$U\_id_{(b,c)} = b^{\alpha\_id} c^{\beta\_id}, id = normal, high \quad (34)$$

According to the principle of the economic man hypothesis, each type of consumer maximizes the utility U according to its own expenditure constraint function, $bc\_I = P_b \times b + P_c \times c$ (P_b and P_c are the average price of BC goods in the previous period).If the consumer's marginal utility λ to money is a constant, then it is easy to know that the monetary utility of spending a marginal b when utility is maximized should be equal to the monetary utility of spending a marginal c, so that the

consumer will not continue to adjust the choice. The simultaneous equations are:

$$\begin{cases} MU_b = \lambda \times P_b \\ MU_c = \lambda \times P_c \end{cases} \tag{35}$$

The deformable reading expenditure constraint function has:

$$\begin{cases} \frac{MU_b}{P_b} = \frac{MU_c}{P_c} \\ bc\_I = P_b \times b + P_c \times c \end{cases} \tag{36}$$

Marginal utility is the partial derivative of the value $U_{(b,c)}$. Finally, the estimated number of two types of consumer goods purchased by a consumer whose expenditure for the purchase of bc is:

$$\begin{cases} b = \frac{bc\_I}{(\frac{\beta}{\alpha}+1)\times P_b} \\ c = \frac{bc\_I}{(\frac{\alpha}{\beta}+1)\times P_c} \end{cases} \tag{37}$$

In order to better distinguish the preferences of ordinary consumers and high-end consumers in this model, the preference for Class b goods is defined as:

$$prefer_b = \frac{\beta}{\alpha} \tag{38}$$

For the average consumer, their $prefer_b$ is relatively larger, and they can buy more common goods in the lower spending range.On the contrary, high-end consumers have a stronger preference for c and will buy more c under a larger threshold_I expenditure. In order to ensure the continuity of consumption utility and wealth growth, the multiplier ρ is introduced at threshold_I, the critical value of expenditure grade change, to ensure the uninterrupted utility of ordinary consumers and high-end consumers here:

$$U\_normal_{(b,c)} = \rho \times U\_high_{(b,c)} \tag{39}$$

2.5.2 Product Matching

After non-unemployed households receive wage income and bank dividend, they combine it with the principal withdrawal and deposit interest from the previous expenditure plan, define it as $act\_earn_{i,t}$, and then put it into the expression $\mathrm{exp\_I_{i,t}}$ to obtain the actual expenditure plan as follows:

$$act\_I\_plan_{i,t} = min(act\_earn_{i,t}, (1 - \mathrm{Inertia}) \times (\xi\_y \times act\_earn_{i,t} + \xi\_w \times \mathrm{D_{i\ ,\ t-1}}) + \mathrm{Inertia} \times \mathrm{act\_I_{i,t-1}}) \tag{40}$$

If $act\_I\_plan_{i,t}$ is less than the current benefits bail_m, then add the id for the household and the amount of the need to relief the dictionary $\{\mathrm{i}: \mathrm{bail\_m} - act\_I\_plan_{i,t}\}$, and the act_I_plan in the update value of bail_m. It is obvious that such workers in need of relief are only found among entrepreneurs and bankers, because the wages of wage earners are guided by the government to exceed the benefits. On the other hand, for all unemployed persons who are $\mathrm{unemployer_{t,3}}$, they receive full government benefits and only consume in category A, and do not use the deposit interest they receive at the beginning of the period, which they deposit in the bank as consumption balance at the end of the period.

Now do the consumption matching. When the market of A is open, all households consume class A products first, and the matching mechanism is similar to that of the labor market, which is also based

on the probability selection model of relative prices. The higher the price of commodity A, the lower the probability of being selected. During the matching process, each family buys A fixed amount of product A before the process stops.

The matching of BC consumer goods also follows the mechanism of low price and high probability. All households capable of hedonic consumption have their own planned purchase demand(b,c), but households will only enter the BC market to match each other once. Now taking Market B as an example, the Python code flow is as follows:

①The families entering the BC market are randomly shuffled, and shuffle_enter_bc_family_id is obtained.

②Iterate through shuffle_enter_bc_family_id.If the list of businesses selling B is not empty, that is,len(all_B_list)>0,Family i begins to extract a firm j from all_B_list with the probability distribution $P(i,j) = \frac{price\_dict}{sum(list(price\_dict.values()))}$. If it is empty, that is, all the B's have been sold but the family still needs them, then the program stops.

③ The $Price_j$ amounts that can be bought by the expenditure amount of Class b products held , which is compared with the number of remaining products of enterprise j, and the smaller value is compared with the number of b products needed by family i, which is as follows:

$$consume\_B[i] = \min(family\_b\_demand[i], \min(int(Pb \times family\_b\_demand[i]/B\_price), B\_saled\_production))$$

consume_B[i] is the final amount of goods consumed by household i from company j, and B_saled_production is the number of remaining pieces of company j.Update to $B\_saled\_production -= consume\_B[i]$ .And get the remaining amount of family i after consumption,$bc\_I[i] -= consume\_B[i] \times B\_price$

④ If $B\_saled\_production == 0$,Then delete the j enterprise from all_B_list and price_dict, and return ② to continue traversing the remaining families.

The Category C consumer market is exactly the same as the B consumer market. In this way, the sharing family can only match once when buying BC, although it can reduce the algorithm complexity, but it will bring greater consumption matching friction. The essence of this problem is that enterprises are sensitive to the judgment of the demand side, which in turn affects more economic activities of the target output - loan - employment - output, and brings huge non-market noise effects to the economy. What I have done with this is to lower the upper threshold of the sales-supply percentage in the production formulation to allow companies to match the macro factors that tribally better judge production growth.

Finally, the remaining amount of the consumer after consumption in this section is obtained bc_I.

2.5.3 Enterprise Profits and Consumers Balance

Set the number of pieces sold by all enterprises to saled_production.For an existing company j, its EBIT profit is:

$$EBIT_j =$$

$$RP_{t-1,j} + \mathrm{F\_D_{t-1,j}} \times \mathrm{r_D} + \mathrm{F\_D\_change\_1_j} + \mathrm{all\_loans_j} + \mathrm{P_j} \times (Prod_{j,t} - \mathrm{saled\_production}) - wage_{j,t} \times (|\mathrm{pros\_w}_{j,t,3}| + \mathrm{WR} \times |\mathrm{pros\_m}_{j,t,3}|) \quad (41)$$

The transformation enterprise k has:

$$EBIT_k = RP_{t-1,k} + \mathrm{F\_D_{t-1,k}} \times \mathrm{r_D} + \mathrm{F\_D\_change\_1_k} + \mathrm{all\_loans_k} + (\mathrm{D_{k,t,2}} - \mathrm{D_{k,t,3}}) + \mathrm{P_k} \times (Prod_{k,t} - \mathrm{saled\_production[k]}) - wage_{k,t} \times (|\mathrm{pros\_w}_{k,t,3}| + \mathrm{WR} \times |\mathrm{pros\_m}_{k,t,3}|) \quad (42)$$

New enterprises l are:

$$EBIT_l =$$

$$\mathrm{all\_loans_l} + (\mathrm{D_{l,t,1}} - \mathrm{D_{l,t,2}}) + \mathrm{P_l} \times (Prod_{l,t} - \mathrm{saled\_production[l]}) - wage_{l,t} \times (|\mathrm{pros\_w}_{l,t,3}| + \mathrm{WR} \times |\mathrm{pros\_m}_{l,t,3}|) \quad (43)$$

For any firm j, if its EBIT is unable to repay the current principal and interest, $EBIT_j - \sum_{d=0}^{n-2} loans_{t-d,j} \times \frac{(1+r_L)^n}{n} < 0$, then the bank will offset the same amount with its corporate deposits, which become:

$$\mathrm{F\_D}_{t,2} = min(0, \mathrm{F\_D}_{t,1} - (\sum_{d=0}^{n-2} loans_{t-d,j} \times \frac{(1+r_L)^n}{n} - EBIT_j)) \quad (44)$$

If the company's deposits are not enough, the bank will close its corporate account at the beginning of the next period and delete its id from the principal loan dictionary. And here immediately update the household job status $\mathrm{P}_{t,4}$ and business employment status $\mathrm{pros\_w}_{t,4}$、$\mathrm{pros\_m}_{t,4}$.

For companies that can repay the principal and interest normally, they will not pay the money to the bank until the beginning of the next period. Their profit after interest and tax is: $\mathrm{netprofit_{j,t}} = (EBIT_j - \sum_{d=0}^{n-2} loans_{t-d,j} \times \frac{(1+r_L)^n}{n}) \times (1 - tax)$

Entrepreneur j, based on the current price change and the current total real wages, decides that the retained profits are:

$$RP_{j,t} =$$

$$min(max(wage_{j,t} \times (|\mathrm{pros\_w}_{j,t,3}| + \mathrm{WR} \times |\mathrm{pros\_m}_{j,t,3}|) \times \mathrm{inflation_t}, wage_{j,t} \times (|\mathrm{pros\_w}_{j,t,3}| + \mathrm{WR} \times |\mathrm{pros\_m}_{j,t,3}|)), \mathrm{netprofit_{j,t}}) \quad (45)$$

If there is still surplus profit, entrepreneur j shares it in proportion to the dividend: $\mathrm{share_{j,t}} = (\mathrm{netprofit_{j,t}} - RP_{j,t}) \times (1 - \psi_1)$. And consumers with the remaining amount after consumption: $after\_consume_{i,t} = act\_I\_plan_{i,t} - bc\_I[i]$. They deposit these dividends and balances in the bank, and the bank's deposits and reserves change by equal amounts:

$$TD_{t,2} = TD_{t,1} + \sum_{i \in \mathrm{P}_{t,4}} after\_consume_{i,t} + \sum_{j \in \mathrm{firmer_{t,4}}} \mathrm{share_{j,t}} \times (1 - tax) \quad (46)$$

$$R_{t,3} = R_{t,2} + \sum_{i \in \mathrm{P}_{t,4}} after\_consume_{i,t} + \sum_{j \in \mathrm{firmer_{t,4}}} \mathrm{share_{j,t}} \times (1 - tax) \quad (47)$$

2.6 Governments and Central Banks

2.6.1 Government

In this paper, the function of the government is simple, its tax is only used to support A industry

support_newA_t, overtime pay to overtime_costsA_t, relief payment all_bail_t, and interest on government bonds held by the central bank $r_B \times \text{bonds}_{t-1}$. If the government's current income is all_tax_t and cash g_cash_{t-1} and the profits transferred to the government by the central bank in the previous period, $\text{central\_profit}_{t-1}$ (in order to prevent the central bank from becoming too large), cannot meet possible expenditures, then the government issues new bonds to the central bank to obtain sufficient liquidity.In return, governments with fiscal surpluses would pay off their debts to the central bank. There is the following expression:

$$\text{if } \text{all\_bail}_t + \text{overtime\_costsA}_t + \text{support\_newA}_t >= \text{g\_cash}_{t-1} + \text{all\_tax}_t + \text{central\_profit}_{t-1}:$$

$$\text{g\_cash}_t = 0, \text{bonds}_t = \text{bonds}_{t-1} + (\text{all\_bail}_t + \text{overtime\_costsA}_t + \text{support\_newA}_t - \text{g\_cash}_{t-1} - \text{all\_tax}_t) \quad (48)$$

$$\text{else: } \text{g\_cash}_t = \max(0, (\text{g\_cash}_{t-1} + \text{all\_tax}_t) - (\text{all\_bail}_t + \text{overtime\_costsA}_t + \text{support\_newA}_t) - \text{bonds}_{t-1}) \quad (49)$$

$$\text{bonds}_t = \max(0, \text{bonds}_{t-1} - ((\text{g\_cash}_{t-1} + \text{all\_tax}_t) - (\text{all\_bail}_t + \text{overtime\_costsA}_t + \text{support\_newA}_t))) \quad (50)$$

2.6.2 Central Bank

In addition to providing financial liquidity to governments, another important function of central banks is to act as lenders of last resort to banks. Not only does the central bank hold banks' reserves as a hedge against lending risk, it also provides banks with advances if they need extra liquidity. The upper limit of advance payments depends on a mechanism for preventing price fluctuations in the circulation of "money-commodity".

The central bank will estimate the current exp_GDP and the currency quantity exp_money required for commodity circulation based on historical information (memory time series, giving different weights to the actual GDP of recent periods (weight sum is 1, and it is decreasing from the current time point) and add them together. If the degree of exp_P change compared to the price P_{t-1} of the previous period greatly exceeds the percentage Ω of the price change inflation_{t-1} of the previous period, then the central bank will consider that the economy of the current period will be excessively volatile, which is a precursor of crisis, and the central bank will refuse to provide the advance payment exceeding the volatility threshold, and the economy will restart. The maximum advance payment benefits for the current period are:

$$\text{bail\_A} = \Omega \times |\text{inflation}_{t-1}| \times P_{t-1} \times \text{exp\_P} + \max(P_{t-1} \times \text{exp\_P} - \text{exp\_money}, \text{exp\_money} - P_{t-1} \times \text{exp\_P}) \quad (51)$$

The central bank's balance sheet is absolutely balanced by the reserve currency M (printed), its only liability other than bank reserve liabilities, which can theoretically rise indefinitely without being accountable to anyone; The operation mechanism of the central bank's assets, including cash, bank advances, and government bonds, is determined by changes in the corresponding projects of the government and the banks.

2.7 Table of Events

(1) Banks receive principal and interest on outstanding loans and interest on reserves from the central bank and pay interest to depositors.

(2) Households estimate their expected income and decide on spending plans and deposit withdrawal plans; After the company gives the salary, they will also decide whether the new entrepreneur.

(3) The enterprise makes production plans (target output, price), and decides whether to withdraw enterprise deposits or even take loans according to retained profits and interest income; Enterprises adjust the number of existing employees according to their own funds and target output, and randomly adjust the distribution of employees according to the fixed proportion LR of workers: management; BC enterprises will also consider mutual transformation, entrepreneurs who cannot reach the industry entry threshold will also withdraw household deposits, and finally, under the limit of the total number of BC enterprises, a random part of them will submit a transformation loan to the bank.

(4) Banks pay for deposit withdrawals and, if insufficient, borrow advances from the central bank (if the maximum limit of price fluctuations after the new injection of liquidity is exceeded, that is, the maximum relief capacity of the central bank, then the economy restarts); If sufficient, a dividend is paid and all loan needs are partially or fully satisfied according to priority ranking.

(5) The labor market is open, and enterprises hire labor to obtain actual output; After the wage earners get the real wage and decide the actual expenditure plan, they make the consumption basket according to their preferences under the classification of the threshold of consumption grade. Relief was given to unemployed workers and to entrepreneurs and bankers who could not survive.

(6) The consumer goods market is open, and families have cash left after consumption, and families deposit it in the bank.

(7) The enterprise obtains the sales revenue, judges the principal and interest repayment, if it is not enough, it adds the deductible enterprise deposit to further judge, if it is still not enough, it goes bankrupt; Companies with net profits decide to retain profits and dividends, which entrepreneurs deposit in the bank.

3. Numerical Simulation Experiment

3.1 Parameter Settings

Set an economy with 10,000 households; At the beginning, there are 50, 10 and 10 enterprises in each of the three categories of A, B and C industries, and the fixed number of A enterprises has been 50; The employment status of the company (number of workers and number of executives) is (10, 1), (1, 1) and (3,1) respectively, and the salary of the workers is 40 yuan. At the beginning, each family received a deposit of 500 yuan; The dividend ratio of enterprises, banks and central banks is ψ_1、ψ_2、ψ_3=0.3, 0.1, 0.8; Deposit interest rate, loan interest rate, reserve interest rate, advance interest rate, government

bond interest rate and reserve ratio are respectively: r_D、r_L、r_R、r_A、r_B、R=0.02, 0.03, 0.01, 0.015, 0.03, 0.1

For other parameters that are important or used in various experiments, the baseline conditions are:

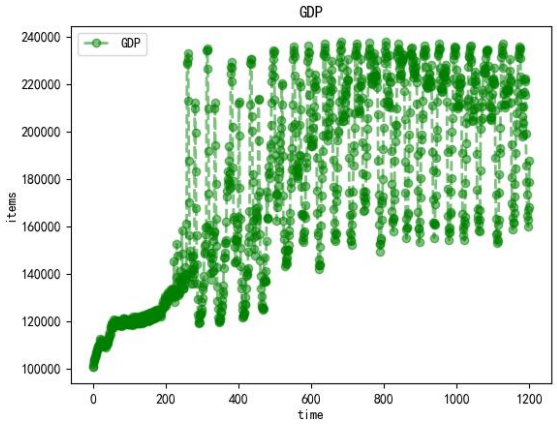
LR、LW	5,10
yield_*(*=ABC)	200,20,14
Pa、Pb、Pc	2,8,26
β_nor，prefer_bc_nor	0.1,2
β_high，prefer_bc_high	0.05,0.9
Inertia,ξ_y,ξ_w	0.3,0.7,0.22
threshold_b,threshold_c	6,1
b_max,c_max	10,4
n	4
production_share_weight,production_price_weight	0.01,0.01
price_share_weight,price_price_weight	0.01,0.01
y1,y2,y3,y4	0.2,0.2,0.1,1.1
κ	0.5
max_firms	900
consume_friction	0.75
k,b	0.2,-0.12
prob_rate	1.5
P_index_B,P_index_C	12,10
demand_decline_rate	0.5
f,h	0.1,-0.1
min_BorC_nums	20

production_share_weight,production_price_weight,price_share_weight,price_price_price_weight is the synonym of α1, α2, α3, and α4.In the code it simply limits the growth blindness of the firm with the largest market share and the most affordable relative price.

3.2 Baseline Experimental Results

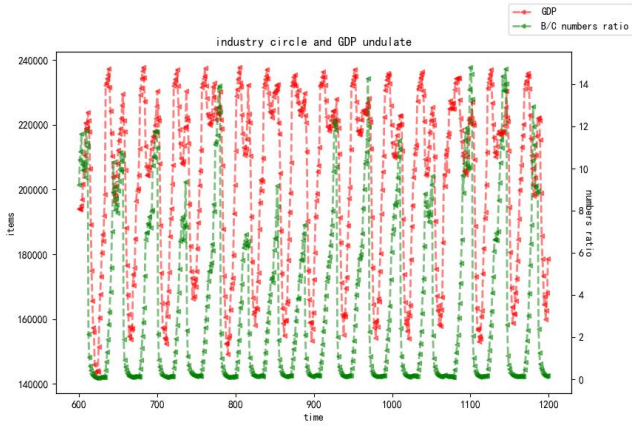
3.2.1 Economic Macro

3.2.1.1 GDP



Graph 1

GDP is calculated according to the number of commodity transactions, it does not need to consider any direction of price changes, and essentially reflects the total labor output of the society with the productivity unchanged. It can be seen from graph 1 that after the 200th period, GDP showed regular cyclical fluctuations. The length of A cycle was about 30-40 periods, and the peak was close to 10,000 ×10 pieces A+ 10,000 ×10 pieces B+ 10,000 ×4 pieces = 240,000 pieces, which happened to be the largest total consumption demand in the society.



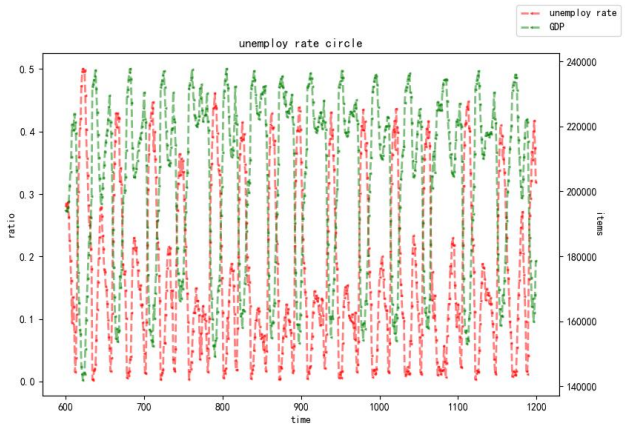
Graph 2

In order to study the impact of industry transformation on GDP fluctuations, a time series of the ratio of the number of enterprises in B/C is introduced here. When this value increases, it indicates that industry B is prosperous, and vice versa. In graph 2, when industry B (green curve) begins to decline in a fluctuating cycle, GDP (red curve) follows closely behind. Then GDP rises, the number of enterprises in industry B remains stable for a period of time (the green trough is longer), because the 20 enterprises in industry limited by min_B_nums, the smallest size of the industry, realize the supply recovery through the adaptive supply and demand adjustment of Class B demand in the total market; When the sales volume of industry B is greater than that of industry C, and Class C enterprises continue to

transform into B enterprises, the number of B enterprises rises to the peak, and GDP reaches the second peak, but it is slightly lower than the first peak corresponding to the 20 oligopoly B enterprises in the trough period, which should be caused by the contraction of supply caused by zero-sum competition in the crowded market of class B.

In this regard, the first important conclusion of this paper is drawn: the alternating rise and fall of industries brought about by industry transformation will lead to cyclical fluctuations of GDP, among which the pillar B enterprises (with greater demand) are the dominant force, which determines the fundamental change of production.

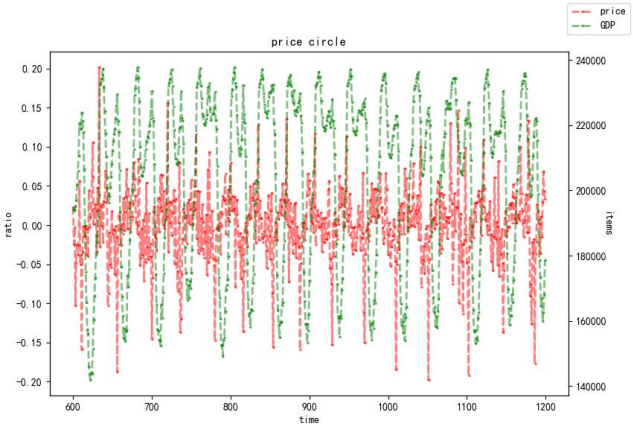
3.2.1.2 Unemployment Rate



Graph 3

The unemployment rate and GDP show the opposite pattern, which conforms to the procedural facts in the general literature. A specific mechanism should be that the productivity yieldB of commodity B industry is not much higher than the productivity yieldC of commodity C industry. When pillar B industry prospers, it also needs a lot of labor.

3.2.1.3 Price Changes

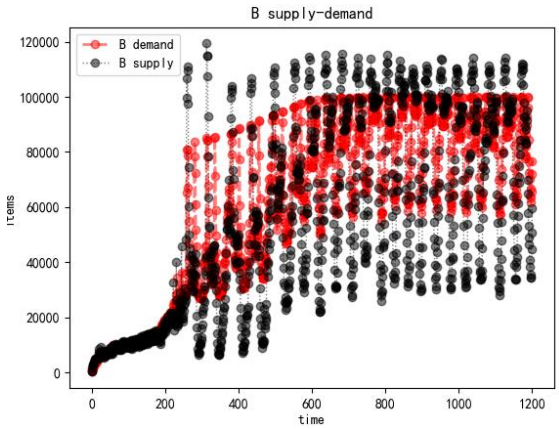


Graph 4

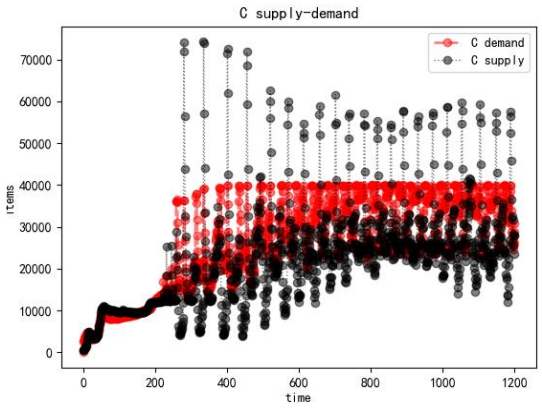
The price change in this model is counter-cyclical, because the price of ordinary goods is cheaper than the price of high-end goods, and when it is consumed in large quantities (GDP is at the peak), the relatively cheap part of the price basket calculation will increase, resulting in negative price change.

3.2.2 Industry Development

3.2.2.1 Industry Fundamentals

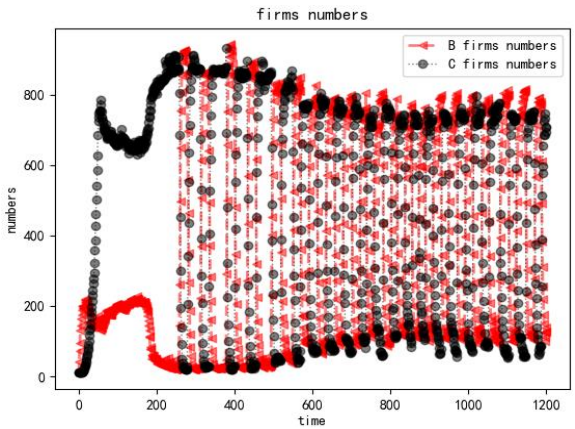


Graph 5

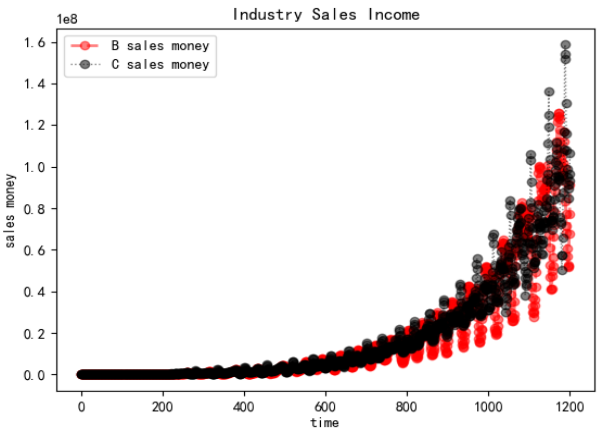


Graph 6

Graph 5 and graph 6 show the supply-demand relationship of the two industries respectively, both of which show the shape of supply-demand fluctuations, reflecting the effective regulation of the market mechanism. One can also see a certain degree of timing difference in the maturity of the industry: the high-end C industry entered the cycle of demand after reaching the peak of 40,000 pieces after 250, and this in the B industry until 500, the demand began to peak. This reflects the priority saturation of the high-end industry compared with the ordinary industry, which is behind the rich consumers' extreme preference for high-end products, when they buy enough 4 C, their increased wealth will gradually increase the purchase of B, until the upper limit of 10.

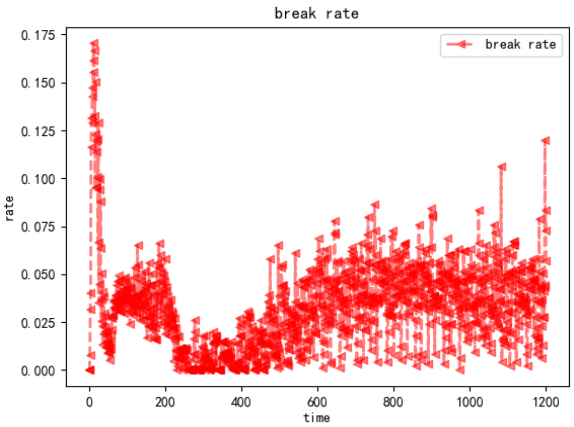


Graph 7

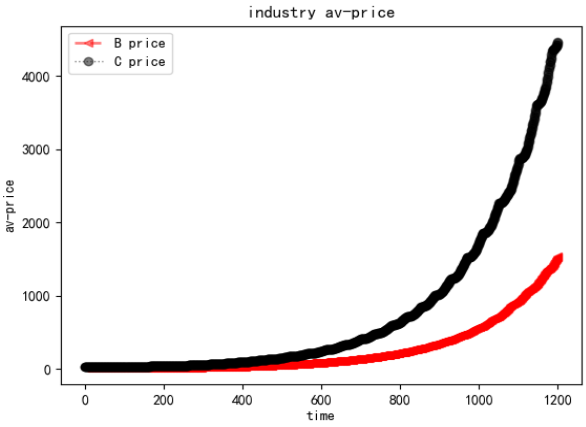


Graph 8

Graph 7 graph 8 reveals the basis of transformation and the distribution of enterprises during the rise and fall of the industry. In addition, the total number of enterprises is always around 900, which indicates that the class transition channel of new enterprises is effective when the bankruptcy rate (graph 9) is not 0.The price of C rose faster, but in the 1200 period, the two still maintained a gap of about 3 times the initial, ensuring the price rationality of surpassing each other's sales.

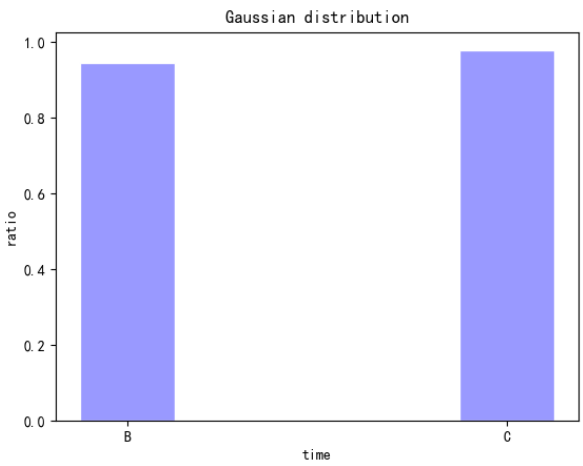


Graph 9

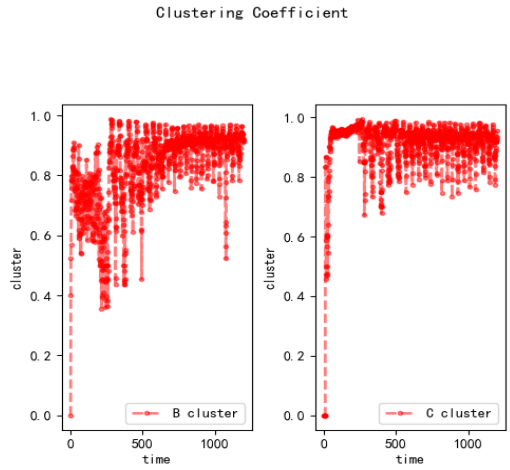


Graph 10

3.2.2.2 Industry Scale Distribution



Graph 11

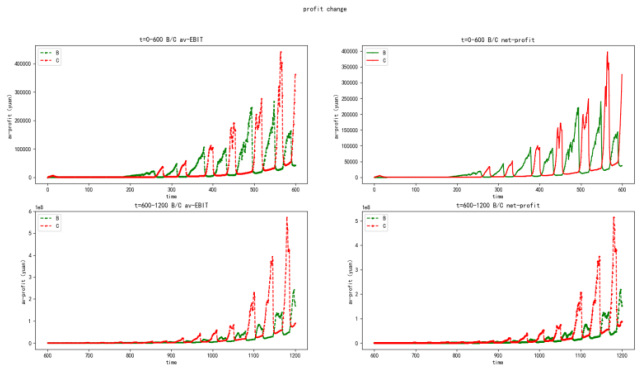


Graph 12

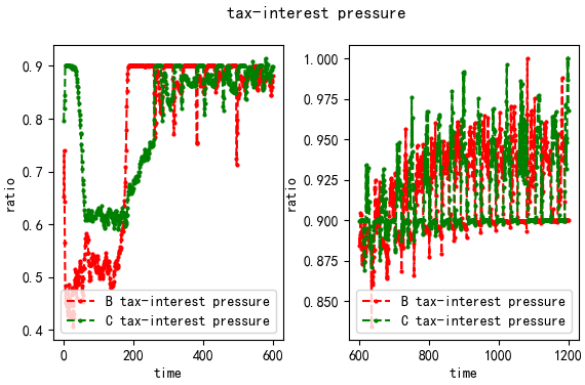
In graph 11, the size of enterprise B presents a normal distribution in 1107 phases in the period of 1200, while that of enterprise C presents a normal distribution in 1159 phases, both of which are greater than 90%. It is believed that this model achieves a general procedural result: the size of enterprises in the industry presents a normal distribution. At the same time, there is another important feature of this model. In graph 12, the scale of enterprises is clustered, and the average clustering coefficient of time series reaches more than 0.8, which fluctuates between 0.7-1 after the industry matures in 500 periods.

This feature should be caused by the transformation mechanism of enterprises in transformation according to the average industry scale of the previous period. Similarly, the effect of imitation-clustering is exacerbated by the fact that new companies produce at the average scale of the previous period.

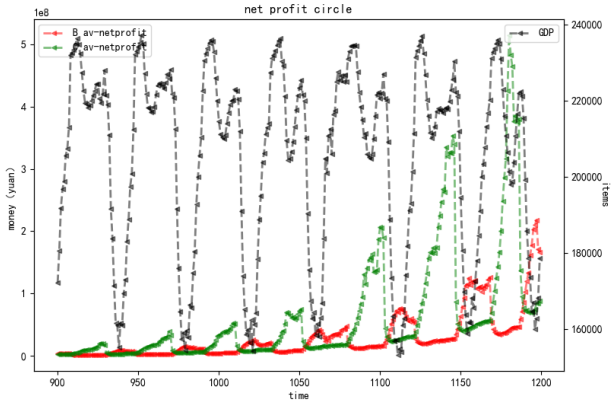
3.2.2.3 Industry profit



Graph 13



Graph 14



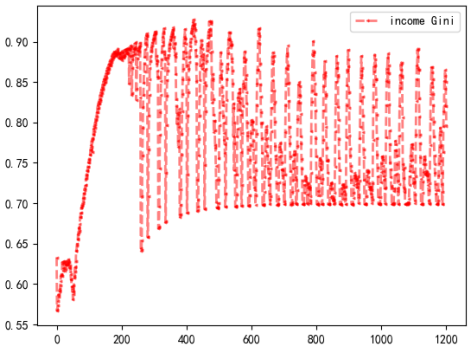
Graph 15

In the average profit of the industry, obvious cyclical fluctuations can be seen after the 200th period. It can also be seen from graph 15 that the average net profit of industry B is counter-cyclical, while industry C is pro-cyclical, which should be closely related to the limited market capacity. When the total demand has reached the highest point, only the number of competitors in the industry determines the average profit. In the horizontal comparison, the profit of BC industry always has cyclical dislocation, and the profit peak of C is more and more overwhelming than that of B. In graph 14, the vertical axis value = Net profit/EBIT. The greater the value, the smaller the interest and tax burden; BC industry before the 500 period of interest and tax burden is below 0.9, the interest and tax burden is relatively heavy; After the 600th period, the lower limit of fluctuation of the interest and tax burden

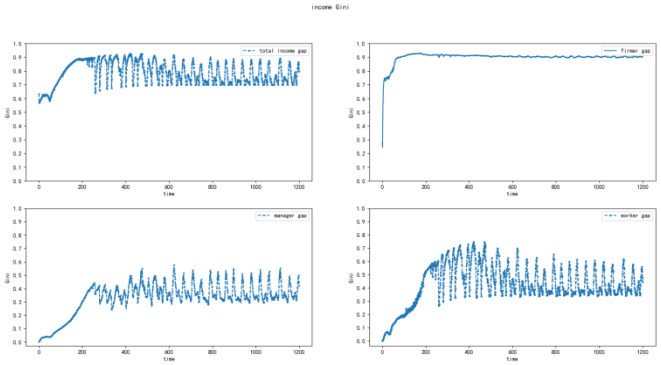
becomes higher and higher as time goes by. After the 1000th period, the interest and tax burden is rarely lower than 0.9, which indicates that with the tax unchanged, the interest borne by enterprises is relatively smaller and smaller, and the industry needs bank loans less and less in the later stage of development. In essence, it is just a kind of supervision on licensing and transformation. For new entrepreneurs, the wealth they accumulate at a later stage will only allow them to easily move up the ladder without the need for bank loans, suggesting that in a closed economy (essentially, demand cannot grow indefinitely) banks' function as a capital distribution hub is diminishing as households' own wealth increases.

3.2.3 Social Inequality and Family Utility

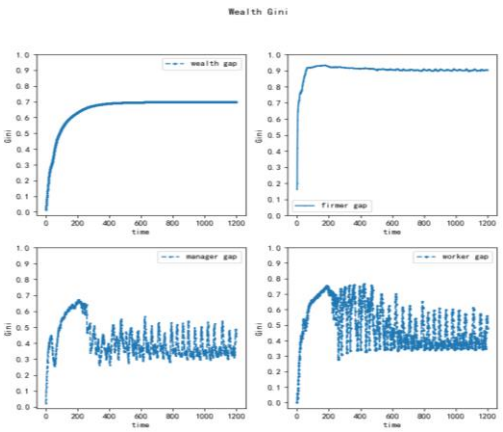
3.2.3.1 Gross Income Inequality



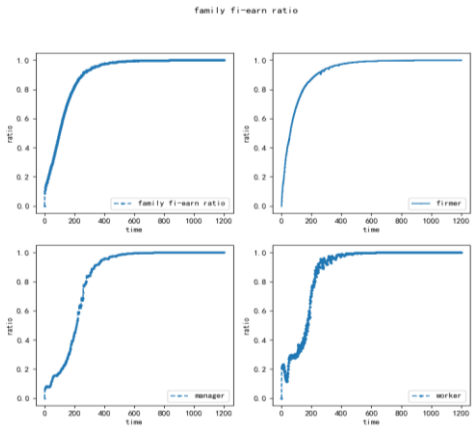
Graph 16



Graph 17



Graph 18

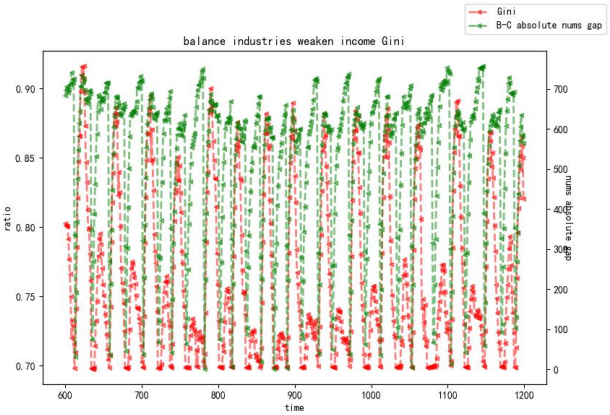


Graph 19

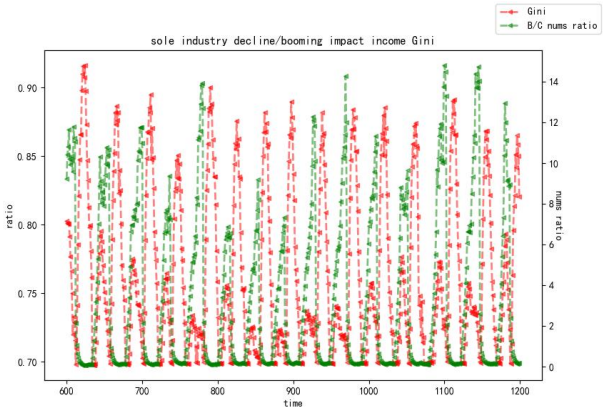
In the Gini coefficient of various types of total income, executives and workers fluctuate sharply, which caused by entrepreneurs going bankrupt and becoming new executives or workers .The gap between entrepreneurs' total income is also huge, remaining near 0.9; On the whole, the economy in this paper has the ability to spontaneously adjust the gap in total income, and the Gini coefficient of total income fluctuates between 0.68 and 0.9, which should be caused by the cyclical changes in the unemployment rate during the rise and fall of the industry, because the total income of the unemployed is not only

financial income, but only bail-money income. Wealth inequality is not the same as gross income inequality, which should be determined by intra-grade homogeneity in consumption patterns and by the share of financial income (Graph 19).

Further, I studied the correlation between gross income inequality and the rise and fall of industries:



Graph 20

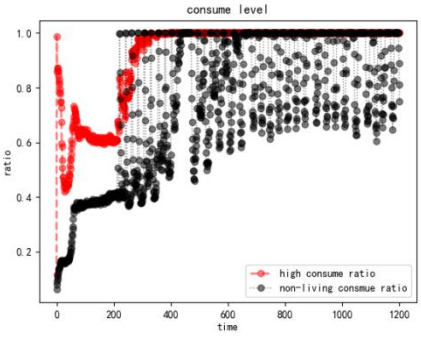


Graph 21

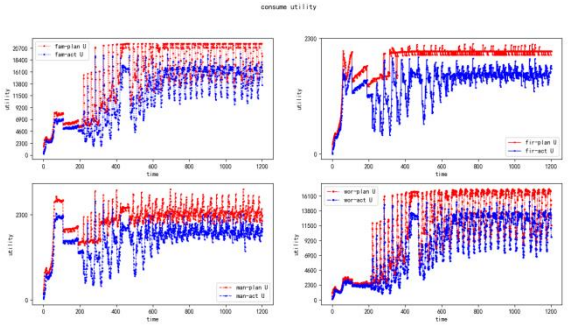
When the number of enterprises in industry B and industry C is the same, the Gini coefficient of income is the smallest, which constitutes the lower bound of inequality fluctuation. In Graph 22, when the green curve (the absolute difference in the number of B-C) is at the trough, the red curve (the Gini coefficient of total income) also reaches the trough. When the B or C industry is in an extreme boom or recession will lead to great inequality of income, the Gini coefficient is high, this law can be shown in Graph 23: when the green curve (the number of firms in B/C) peaks or troughs, the red curve (the Gini coefficient of income) peaks.

In this regard, the second important conclusion of this paper is drawn: Inequity will affected by the balanced development among various industries in economic sector,and it strengthen certainly during any booming/declining of sole industry.

3.2.3.2 Household Consumption Utility



Graph 22

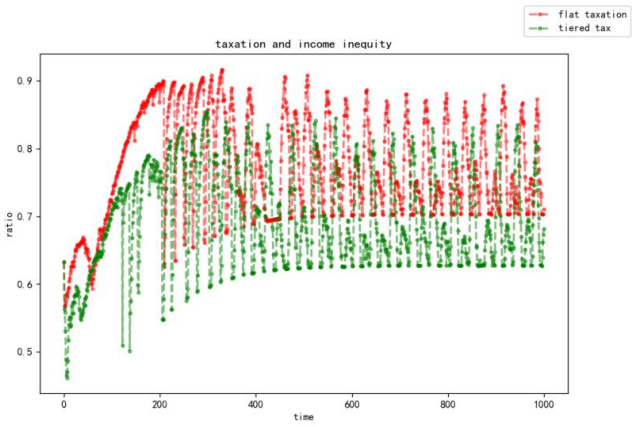


Graph 23

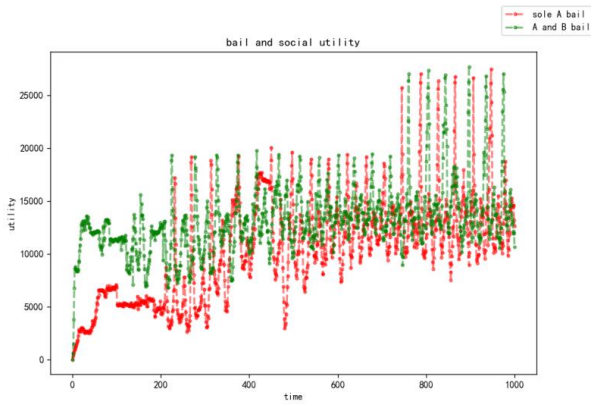
In graph 22, the proportion of non-subsistence consumption shows cyclical fluctuations, because they directly depend on the proportion of employed people. However, after the family wealth has accumulated for more than 200 periods, once they are successfully employed and participate in production, they are allowed to consume BC products and directly become high-end consumers. In the household consumption utility shown in graph 23, the utility of entrepreneurs and executives is relatively stable, while the utility of workers fluctuates sharply, and the utility of workers accounts for a majority of the total social utility, which in turn brings drastic fluctuations to the social utility. It should be that workers are more susceptible to the adjustment of production plans in the economic cycle and are given priority to be laid off in order to maintain employment than LR, thus becoming unemployed. Loss of enjoyment consumption utility caused by; At the same time, in the utility diagram of various groups in graph 23, none of the planned utility was fully satisfied in any phase. Select a time point and observe the supply of graph 5 and graph 6, and there is indeed a situation that BC supply is greater than BC demand, then these two points fully demonstrate the existence of consumer product matching friction.

4. Policy Experiment

4.1 The Government Implements Ladder Tax and Subsidizes Class B Consumer Goods for the Unemployed



Graph 24



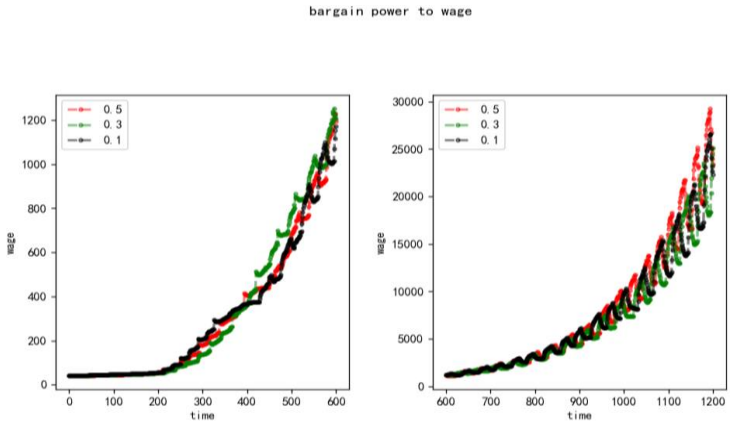
Graph 25

The ladder tax here takes the general type of progressive increase in tax Settings, for the top 1%, 10%, 30%, 50%, 80% of total income, take additional tax treatment beyond the income threshold, respectively, the proportion of 0.99, 0.85, 0.7, 0.5, 0.3. The government's subsidy is to allow the unemployed to consume the least number of B goods+2 among the employed people in the previous period, and to give the unemployed an additional amount of benefits.

I find that after progressive taxation is adopted, it can be seen from graph 24 that the upper/lower limit of income Gini coefficient fluctuation is effectively reduced, which accords with the general procedural fact.

In graph 25, allowing the unemployed to consume A and then consume B at the same time effectively supports the lower limit of social utility.

4.2 Changing the Bargaining Power of Workers κ

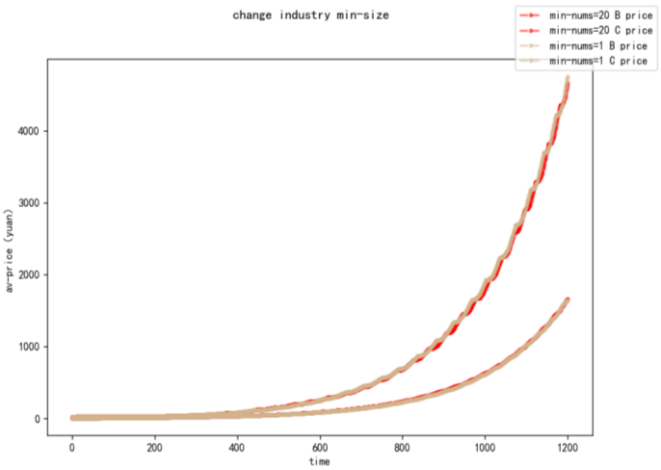


Graph 26

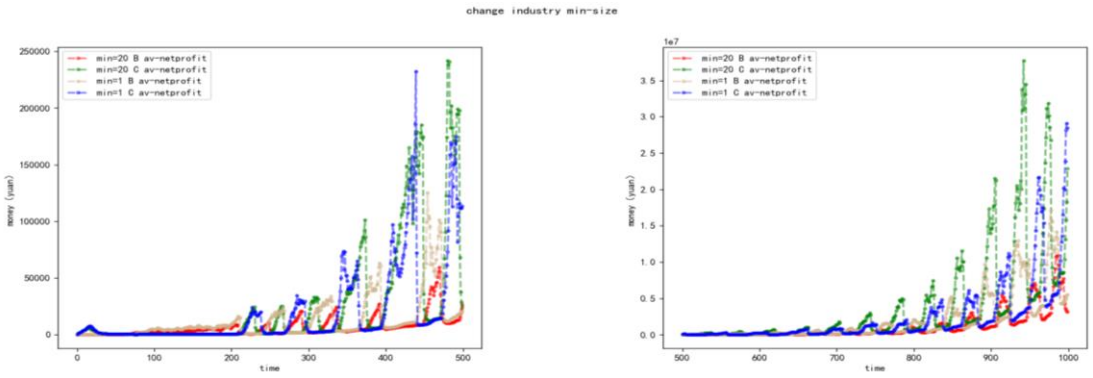
The smaller the κ, the higher the bargaining power. In graph 26, with the decrease of κ, wages can become higher in the early period of economic operation, but it is not conducive to the long-term rapid growth of wages. Instead, after 400 periods, the relatively moderate bargaining power of k=0.3 makes wages increase faster. Finally when the time ups to 1000, the smallest bargaining power k=0.5 has the best benefits for wage circles' increase.

4.3 Changing the Industry Minimum size

4.3.1 min_BorC_nums=1



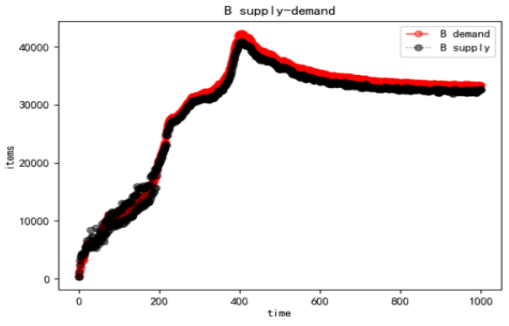
Graph 27



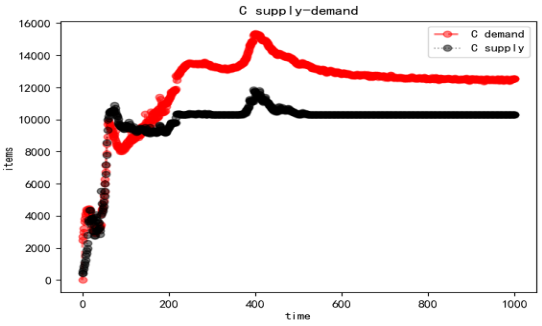
Graph 28

The av-net profit of industry B will increase with the decrease of the number of transition thresholds, and the opposite is true of industry C. In the case of similar price changes, the opposite change in the average net profit of the B/C industry should be determined by the strength of upper consumer demand for B/C. Under the same B/C industry commodity matching friction, when the BC supply in the trough period is not enough, stronger demand can make fewer enterprises according to the number of sales - production industry macro factors in a relatively short period of time to rapidly increase production, and then become oligarchs, occupy the profit highland.

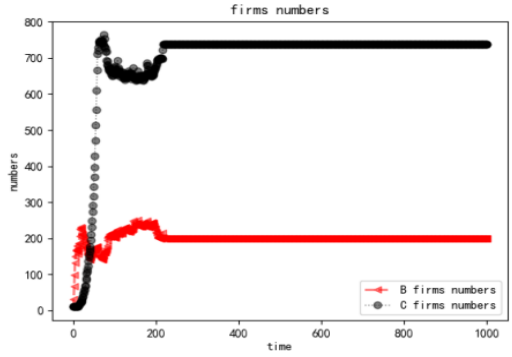
4.3.2 min_BorC_nums = 200



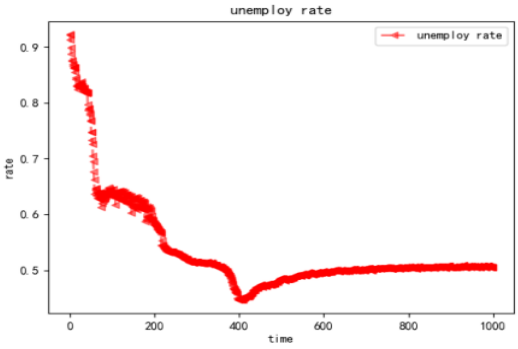
Graph 29



Graph 30

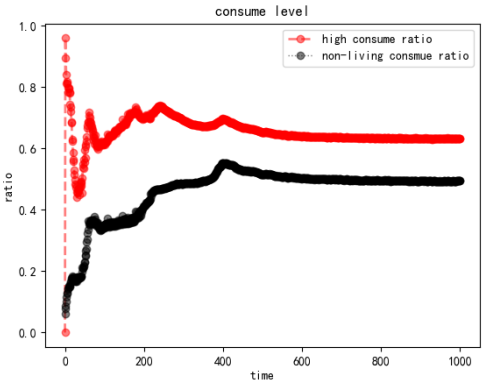


Graph 31

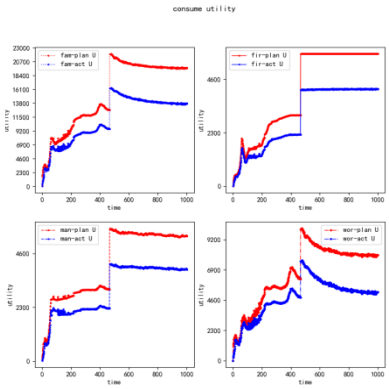


Graph 32

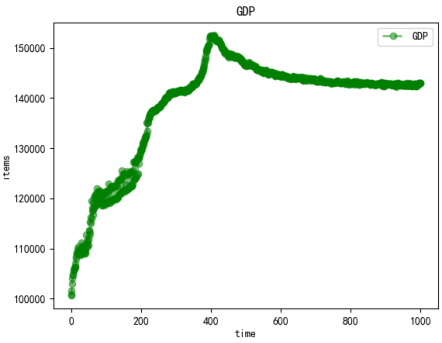
The minimum industry size of 200 will lead to the failure of economic development, because enterprises cannot fully transform among industries, and then cannot take advantage of the market selection mechanism of different levels of consumers' preference for BC (graph 29 and 30 are in short supply), and finally, 900 production enterprises cannot achieve reasonable allocation and fall into a static state (graph 31).Social employment is not enough (graph 32), the proportion of non-subsistence consumption and high-grade consumption is low (graph 33), and the total social utility and GDP cannot reach a high level, and even begin to decline (graph 34, 35).



Graph 33

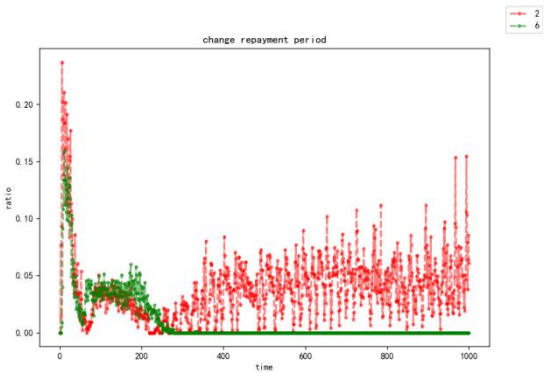


Graph 34

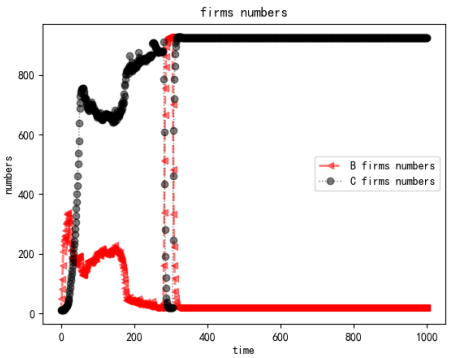


Graph 35

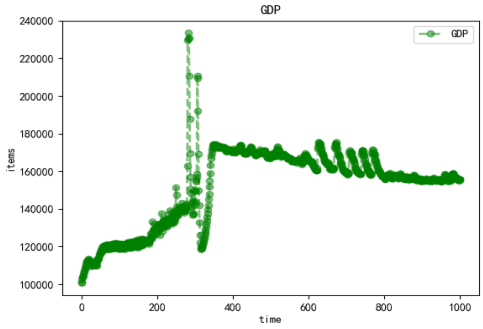
4.4 Change the Bank Repayment Term n



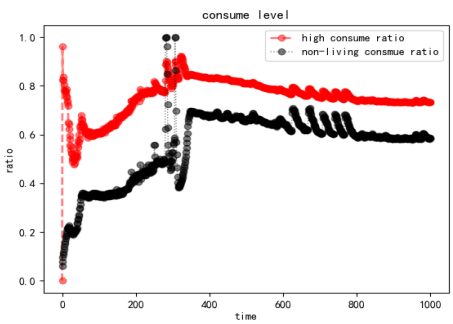
Graph 36



Graph 37



Graph 38



Graph 39

After excessive deregulation of bank loans to enterprises, the bankruptcy rate of enterprises will drop to 0 in the middle and late period, and then there will be no new enterprises, the BC industry is in a static state, production resources cannot be fully allocated, resulting in a low GDP and social consumption grade can not be upgraded.

5. Conclusion

This paper successfully explores the reasons for cyclical economic fluctuations through a macro-agent model of two-industry cycle replacement: Industry turnover affects the employment and income of the household sector, and then negatively feedback the result of industry turnover through the preference selection mechanism, making the industry undergo another round of turnover, and the total economic output value presents cyclical fluctuations. Other macro variables, including unemployment rate, prices and industry profits, income inequality and social consumption utility, also show similar fluctuations.

In the policy experiment, we also found that if the government tries to limit the smooth degree of enterprise transformation due to the excessive regulation stance of economic fluctuations, it will lead to the failure of market regulation mechanism, unreasonable distribution of production resources, economic downturn and low social utility. This requires governments to strike the right balance between economic volatility and sustained growth; To curb income inequality, the government should adopt a more flexible step tax and implement effective transfer payments. At the same time, the government should expand the income channels of the working class (enhance financial income, implement consumption subsidies, etc.), instead of blindly improving their ability to negotiate wages. Excessive bargaining power will lead to high production costs, difficult scale development of enterprises, and difficult to maintain rapid wage growth in the long run.

From the perspective of another theoretical experiment, this paper reproduces the heterogeneous commodity modeling in classical economics in which income determines choice preference in the agent model, constructs the total social utility by summing up the utility of the quantity of commodities in the consumption basket, and finds that the utility ceiling of the worker group, which occupies the vast majority of the society, is the highest. In the long-term growth, the consumption support of the workers is conducive to the improvement of the total social utility, which is in line with the certain spirit of prioritization to take care of the weak. The model also realizes the study of industry scale, and finds that the imitative behavior of new enterprises and transforming enterprises will bring clustering distribution to industry scale, which is not conducive to differentiated production and pricing sales.

Finally, as for the outlook, the work in this paper can be used as a starting point for economic fluctuations caused by enterprise transformation. In the further literature flow work, more subdivided niche markets, more diversity and complexity of consumer preferences, the impact of technological innovation and industry barriers on transformation choices, etc., may be more profound reasons affecting macroeconomic operation.

Data Availability Statement

I have shared the macro-agent model python-code to figshare Database. Please choice the newest version. The doi is: https://doi.org/10.6084/m9.figshare.25060043.v4

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