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FIXED CAPITAL AND

WAGE-PROFIT CURVES A` LA

VON NEUMANN-LEONTIEF:

CHINA’S ECONOMY 1987 —2000$

Bangxi Li

ABSTRACT

This chapter aims at making clear growth and distribution of China’s economy 1987 —2000 with ﬁxed capital on the input-output table basis. Since ﬁxed capital data are not sufﬁciently available, one has to estimate ﬁxed capital coefﬁcients. In the outset, this chapter outlines the Sraffa —Fujimori method, which simulates the maximum growth path and estimates the marginal ﬁxed capital coefﬁcients on that path. In the second place, the marginal ﬁxed capital coefﬁcients of China’s economy are estimated. In the third place, the wage-proﬁt curves of China’s

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economy will be drawn, and we discuss some further features obtained by our observations.

Keywords: Marginal ﬁxed capital coefﬁcient; wage-proﬁt curve; China’s economy; Marx-Sraffa model; Sraffa-Fujimori method; Von Neumann-Leontief system

INTRODUCTION

In this chapter, we aim at investigating growth and distribution of China’s economy on the basis of the input-output tables. The tentative goal is to draw the wage-proﬁt curves of China’s economy, and obtain an overview of the position of the actual situation of growth and distribution of China’s economy. We carry out this investigation focusing on ﬁxed capital. Since the available data on ﬁxed capital are very limited, it is necessary to start the task from estimating the ﬁxed capital coefﬁcients.

On the basis of the standard system of [Sraffa (1960)](#_bookmark1), [Fujimori (1992)](#_bookmark2) developed a novel and original method to estimate the marginal ﬁxed capital coefﬁcient by employing the Japan’s gross investment matrix data of ﬁxed capital. The ﬁrst part of this chapter will be spent for an outline of the Sraffa —Fujimori method. That is, the method employed in this chapter reallocate all of consumption items of the ﬁnal demand to invest- ment items proportionally and calculated the marginal ﬁxed capital coefﬁ- cient in the state of the zero consumption, so that it is the calculation with the standard system of Sraffa. In addition, from the angle of compu- tation, to evaluate the state in which zero consumption is observed can be said either to look for the standard system of the original system con- cerned, or to evaluate just the potential greatest growth rate. We adhere fundamentally to [Fujimori (1992)](#_bookmark3), with minor corrections and improve- ments, though.

Second, we apply this method to input-output tables of China’s economy, and estimate the marginal ﬁxed capital input coefﬁcient for 1987 —2000.

Third, we draw the wage-proﬁt curves of China’s economy in a von Neumann-Leontief framework, by applying ﬁxed capital coefﬁcients estimated as above.[1](#_bookmark4),[2](#_bookmark5)

Fourth, we discuss the short- and long-run features of China’s economy of the period by comparing the short- and long-run wage-proﬁt curves, where the short run indicates the case in which ﬁxed capital is ignored.

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ESTIMATION OF FIXED CAPITAL COEFFICIENTS

Basic Framework

[Okishio and Nakatani (1975)](#_bookmark6) reduced a joint-production system a` la Marx — Sraffa[3](#_bookmark7) with aged ﬁxed capital alone as joint-products to a Leontief production system that consisted of only the brand-new goods. Let A, K, F, L stand for input coefﬁcient matrix, ﬁxed capital input coefﬁcient matrix, bundle of wage goods, labor input vector, and let p and r be the production price vector of only brand-new goods, and uniform proﬁt rate, respectively.

p =pMðrÞ

ð1Þ

ð2Þ

MðrÞ = ðψ八ðrÞþ rIÞK þð1þ rÞðAþ FLÞ

ψ八ðrÞ is a diagonal matrix with the rate of depreciation ψi (r) in the diagonal, where for durability τi of ﬁxed capital i,

ψi ðrÞ =  ð1þ rÞh !− 1

ð3Þ

Remark that in the above formulation, one should assume physical durability of ﬁxed capital with constant efﬁciency.[4](#_bookmark10)

If non-productive consumption is disregarded, a Marx — Sraffa activity level system can be similar to the Leontief output system with extra brand- new ﬁxed capital. The equilibrium output system corresponding to the equilibrium production price system [(1)](#_bookmark8) is given by the following:[5](#_bookmark11)

q = MðgÞq ð4Þ

where q and g are an output vector of only brand-new goods and the uni-

form growth rate, respectively, with g = r.

Obviously, for an r≥ 0, M(r) is a non-negative matrix, so it has the Perron —Frobenius eigenvalue 1, and the left (right) eigenvector corre- sponding to 1.

Now, the data of K is not available. Only the data of the gross invest- ment matrix may be available as ﬁxed capital data in the actual input- output tables. Therefore, the next subsection will illustrate how the ﬁxed capital input coefﬁcient matrix K in the above-mentioned theoretical model is estimated from the gross investment data of ﬁxed capital.

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Sraffa —Fujimori Method

The intermediate input Xij, ﬁnal demand Yi, and total output Xi of an input-output table fulﬁll the following relations.

n

Xi = X Xij þ Yi

j = 1

The input coefﬁcient matrix A = (aij) is given by

Xij

aij =

Xj

Let x, I, and C stand for the output-, the investment-, and the consumption- vector, respectively, and

x = Ax þ I þ C ð5Þ

will be obtained from the input-output table. Investment I is the sum total of inventory investment and the gross investment of ﬁxed capital.

Hereafter, we try to ﬁnd the growth rate of Sraffa’s standard system obtained by the following simulation, in which C is equally assigned to I in the ﬁnal-demand item. It is necessary to consider investment of non- durable capital goods and that of ﬁxed capital.

Since inventory investment can be regarded as the accumulation of non- durable goods, it is set to gAx, where g denotes the uniform growth rate.

On the other hand, since the gross investment of ﬁxed capital is divided into net investment and depreciation (replacement investment), the amount of net investment is gKx and the depreciated part is set to ψ八ðgÞKx. We try to estimate K from the angle of the marginal ratio.

Let ΔK denote the net investment matrix, and ΔX, the incremental vector of output. The marginal capital coefﬁcient K will be deﬁned by:

k = 

ð6Þ

Assume that kij = k . Further, we can consider the incremental output as ΔX = gX.

Since the ratio γi of the net investment to gross investment can be

deﬁned as follows:

γi = 1 −

1

ð1þ gÞτi

ð7Þ

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we can consider the net investment matrix as S, where S is the gross

investment matrix of ﬁxed capital, and  is the diagonal matrix with γi in

the diagonal.[6](#_bookmark13)

From this, we can set the marginal capital coefﬁcient k as follows:

γiSij

gXj

k =

In this computation, k is dependent on the uniform growth rate g. [(5)](#_bookmark12) is rewritten as [(9)](#_bookmark14) with K\* ðgÞ = ðkÞ .

x =MðgÞx

MðgÞ = ðψ八ðgÞþ gIÞK\* ðgÞþð1þ gÞA

ð8Þ

ð9Þ

ð10Þ

If λM(g) = 1, g at that point gives the maximum growth rate g\*.

The computational procedure of g\* is described as follows:

(1) Take a sufﬁciently small initial value g0 >0, and M(g) in Eq. [(10)](#_bookmark14) is positive.

(2) For g>0, we can conﬁrm the following. From MðgÞ >0, M(g) is an increasing function of g. Besides, from the Perron —Frobenius theo- rem, λMðgÞ is an increasing function of elements of M(g). Hence,

gt <gt þ 1 ⇔ Mðgt Þ <Mðgt þ 1Þ ⇔ λMðgt Þ <λMðgt þ 1Þ

Let gmax =  − 1. From jgt j <gmax , gt is bounded.[7](#_bookmark15)

Now, if λM(g) < 1, the value of g should be increased; if λM(g) > 1, the value of g will be decreased.

A sequence {g0, g1, g2, …} is generated by

gt þ 1 = 6ðgt Þ =gt þ βð1 − λMðgt Þ Þ

where β >0 represents an arbitrary constant.

If gt is taken near 0, then gt + 1 will appear above the 45° line. Since the tangent of 6(g) is given by

dgt þ 1 d

= 1 − β λMðgt Þ < 1

ð11Þ

dgt dgt

6(gt) will cross the 45° line from the top to the bottom. The relationship between gt + 1 and gt can be expressed in [Fig. 1](#_bookmark17). In view of the above, gt+ 1 =6(gt) has a ﬁxed point gt+ 1 =gt =g\*. gt+ 1 =gt =g\* is

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*gt*+1

*gmax*

*gt*+1 = *gt*

*gt*+1 =6(*gt)*

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0 *g*\* *gt*

Fig. 1. The Convergence of the Iteration.

equivalent to 1 —λM(gt) = 0. Moreover, this ﬁxed point is stable from Eq. [(11)](#_bookmark16). This ﬁxed point can be found by the regula falsi method of numerical computation.[8](#_bookmark18)

(3) For g\*, the marginal ﬁxed capital coefﬁcient matrix can be con- structed as follows:

K\* = ðkðg ÞÞ ð12Þ\*

The procedure described in the above may look like the one to compute the maximum growth rate in the golden rule of the von Neumann model. Some may argue that the maximum growth rate of the von Neumann growth model is conceptually different from the maximum proﬁt rate of Sraffa’s standard system. Nonetheless, they are formally equivalent. In the same manner to estimate the maximum growth rate we evaluate the wage-proﬁt curve in the next section, the concept of which comes from [Sraffa (1960)](#_bookmark19).

Notes on Data

In this chapter, the gross investment matrix of each year of China is aggre- gated to the matrix of the same size with similar sectors: the 33-sector input-output tables for 1987, 1990, 1992, 1995, and the 40-sector input- output tables for 1997, 2000 are aggregated to the 24-sector input-output tables. The input-output table data employed were published by the

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National Bureau of Statistics of China (NBSC, 1987, 1990, 1992, 1995, 1997, 2000), and the investment matrix data were estimated by [L](#_bookmark20) (2007). The durability data of ﬁxed capital were published by [Ministry of Finance](#_bookmark21) [of China (1992)](#_bookmark22) and [State Council of China (2007)](#_bookmark23). The details of the input-output tables and durability of ﬁxed capital are shown in [Table 1](#_bookmark24).

The data of the total working population are from the NBSC publica- tion, China Statistical Yearbook 2003 (NBSC, 2003), and the data on the annual working hours per person are from the International Labor Ofﬁce (ILO, 2005) publication, Yearbook of Labour Statistics 2003.

From the input-output tables, the macro marginal capital-output ratio κ of each year can be evaluated by

Pi Pj γiSij

=

gPjXj

Table 1. Codes and Durabilities of 24 Sectors.

|  |  |  |
| --- | --- | --- |
| Code | Sectors | Durabilities (Years) |
| 1 | Agriculture | 16 |
| 2 | Mining |  |
| 3 | Foods and tobacco |  |
| 4 | Textiles |  |
| 5 | Pulp and papers |  |
| 6 | Electricity, steam, and hot water |  |
| 7 | Petroleum and coal |  |
| 8 | Coal gas and coal product |  |
| 9 | Chemicals |  |
| 10 | Non-metallic mineral products |  |
| 11 | Metals smelting and processing |  |
| 12 | Metal products | 12 |
| 13 | General machinery | 17 |
| 14 | Transportation machinery | 9 |
| 15 | Electric machinery | 17 |
| 16 | Precise machinery | 15 |
| 17 | Other manufactured products | 12 |
| 18 | Construction | 40 |
| 19 | Transportation | 13 |
| 20 | Commercial | 10 |
| 21 | Services |  |
| 22 | Finance, insurance, and real estate |  |
| 23 | Education, health, and scientiﬁc research |  |
| 24 | Public administration |  |

Note: Blanks in the durability column indicate that goods concerned are non-durable.

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Table 2. Basic Macro Parameters (1987-2000).

|  |
| --- |
| 1987 1990 1992 1995 1997 2000 |
| Maximum potential growth rate g\* (%) 40.3 35.5 31.9 30.3 30.5 26.6  Macro marginal Capital-output ratio κ 0.873 1.003 1.420 1.587 1.397 2.195 |

The Chinese economy’s maximum potential growth rates g\* and the macro marginal capital-output ratios κ are shown in [Table 2](#_bookmark25).

WAGE-PROFIT CURVES A` LA

VON NEUMANN-LEONTIEF

Basic Concept

In the normal production process, many factors are employed, such as raw material and ﬁxed capital with various durabilities and ages. Brand-new ﬁxed capital and aged ﬁxed capital are considered as distinctly different items. Moreover, plural types of commodities are jointly produced by pro- cesses. In a von Neumann system, the equilibrium price problem of such an economy can be described as follows:[9](#_bookmark27)

max {pFjpB≤ pAþ L; p≥0 } ð13Þ

where A, B, F, L, r, and p represent tentatively a rectangular input matrix, a rectangular output matrix, a bundle of wage goods, a labor input vector, the uniform proﬁt rate, and the production price vector, respectively. This is a linear programming problem in which the wage rate w =pF is maximized.[10](#_bookmark28)

Let x stand for the activity level; the dual problem of Eq. [(13)](#_bookmark26) is expressed as follows; assuming a uniform growth rate g = r:

min {LxjBx ≥ Ax þ F; x≥0 }

ð14Þ

This dual problem minimizes the labor input in the economy.

If the above general joint-production system is looked at as a joint- production system, in which aged ﬁxed capital alone is jointly produced,

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then by applying the same procedure of reduction applied by Sraffa — Okishio —Nakatani, we can obtain systems of inequalities similar to Eqs. (1) —(4), which will be called the von Neumann-Leontief system.[11](#_bookmark29)

In short, in a von Neumann-Leontief-type economy, the standard maxi- mum problem [(13)](#_bookmark26) is expressed as follows:

max {pFjp≤ pAþ Lþ p (I þ ψ八ðrÞ)K; p≥0m }

ð15Þ

where notations are the ones introduced in the above mentioned section. The relationship between proﬁts and real wages can be expressed as that

between the proﬁt rate and the number of units of the bundle of wage

goods. Hence, the wage-proﬁt curves should be expressed as a curve com-

posed of points ( ; r) .

Similarly, the dual problem of linear programming problem [(15)](#_bookmark30) is expressed as follows, assuming g = r, that is, with the capitalist non- consumption premise:

min {Lqjq≥ Aqþ F þ (I þ ψ八ðrÞ)Kq; q≥0m }

ð16Þ

where q represents the output vector.

A linear programming problem of this kind should be considered from both short- and long-run perspectives. While the replacement and the net investment of ﬁxed capital are generally carried out in the long run, these can be ignored in the short run. Therefore, the short-run version of the linear programming problem [(15)](#_bookmark30) can be expressed as follows:

max {pFjp≤ pAþ L;p≥0 }

ð17Þ

The dual problem in the short run will be expressed as follows:

min {Lqjq≥ Aqþ F; q≥0 }

ð18Þ

This corresponds to the uniform growth equilibrium with g = r.

Computation Procedure with Respect to Input-Output Data

(1) Calculate the bundle of wage goods F and the labor input vector L.

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The product of the annual total working population N0 and annual working hours h per person gives the total working hours in a year; that is,

H = N0h

The bundle of wage goods per person is the consumption divided by the total working population. In other words, this is equal to  . As for wage goods per unit of labor, one may write

Ci

fi =

H

The bundle of wage goods is then given by F = (fi).

Further, the total added value V0 is expressed by

n n n

V0 = X Wj þX Vj þX Tj

j = 1 j = 1 j = 1

where Wj, Vj, and Tj stand for wages, proﬁts, and taxes of an input-output table, respectively. The working hours per unit of value are evaluated by , and the working hours in sector j is given by ðWj þ Vj þ Tj Þ  . Hence, the labor input necessary for producing one unit of goods becomes

HðWj þ Vj þ Tj Þ

lj =

V0Xj

The labor input vector is represented by L = (lj).

(2) Find the optimum solution for the long-run linear programming pro-

blem, and draw the wage-proﬁt curve.

For each r in the range 0≤ r≤ g\*, solve the long-run standard maxi- mum problem [(15)](#_bookmark30), and ﬁnd the optimum solution p\* .

The long-run wage-proﬁt curve can be represented by a curve com-

posed of points (; r).

(3) Find the optimum solution for the short-run linear programming pro- blem, and draw the wage-proﬁt curve.

Repeat the same procedure of the long run as in the above with respect to Eq. [(17)](#_bookmark31).

Similarly, the short-run wage-proﬁt curve is given by a curve com-

posed of points (; r).

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(4) Estimate the coordinates of the position of the actual Chinese economy.

(i) Since NBSC publishes GDP, total wage amount Θ\*, and the total amount of capital formation S\*, the amount of total proﬁt can be evaluated by

Π\* = GDP − Θ\*

and the accumulation rate is computed by

α\* = 

(ii) For the economy containing ﬁxed capital, the proﬁt rate is esti- mated as

g\*

α\*

r\* =

from α\* evaluated in (i), and the growth rate g\* published by NBSC.

(iii) From r\*, the optimal solutions for the above-mentioned LP pro-

blems [(15)](#_bookmark30) and [(17)](#_bookmark31) can be calculated, and points (; r\* ) and (; r\* ) on the wage-proﬁt curve can be identiﬁed.

(iv) From consumption C (with government consumption included), the wage goods per unit of labor is computed as

fi\* = 

where F\* = ðfi\* Þ . The coordinates of the actual economy are esti-

mated as (; r\* ).

Computation Results

The coordinates data of long- and short-run wage-proﬁt curves a` la von Neumann-Leontief are shown in [Table 3](#_bookmark32) and [Table 4](#_bookmark33), respectively. The wage-proﬁt curves from 1987 to 2000 based on the above-mentioned tables are drawn as in Figs. 2 —7.

The short-run curve is shown for comparison.

Remark that, for computational reasons, some of the maximum proﬁt rate cannot be numerically computed.

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Table 3. The Long-Run Wage-Proﬁt Relationships (1987 —2000).

|  |  |  |
| --- | --- | --- |
| R | 1/pF  1987 1990 1992 1995 1997 2000 | |
| 0.00 | 1.790 1.849 1.935 1.904 1.958 1.889 | |
| 0.02 | 1.701 1.752 1.815 1.781 1.836 1.754 | |
| 0.04 | 1.613 1.656 1.695 1.658 1.715 1.619 | |
| 0.06 | 1.526 1.561 1.577 1.535 1.593 1.482 | |
| 0.08 | 1.441 1.466 1.459 1.413 1.472 1.345 | |
| 0.10 | 1.356 1.372 1.341 1.291 1.351 1.207 | |
| 0.12 | 1.272 1.278 1.224 1.169 1.230 1.068 | |
| 0.14 | 1.188 1.184 1.107 1.047 1.108 0.929 | |
| 0.16 | 1.105 1.089 0.989 0.925 0.985 0.788 | |
| 0.18 | 1.022 0.993 0.872 0.802 0.860 0.645 | |
| 0.20 | 0.939 0.896 0.753 0.678 0.734 0.501 | |
| 0.22 | 0.855 0.797 0.633 0.552 0.604 0.353 | |
| 0.24 | 0.771 0.695 0.511 0.424 0.472 0.201 | |
| 0.26 | 0.686 0.590 0.387 0.293 0.334 0.045 | |
| 0.28 | 0.600 0.480 0.260 0.158 0.191 | |
| 0.30 | 0.511 0.364 0.130 0.018 0.040 | |
| 0.32 | 0.420 | 0.240 |
| 0.34 | 0.326 | 0.107 |
| 0.36 | 0.228 | |
| 0.38 | 0.124 | |
| 0.40 | 0.014 | |

Table 4. The Short-Run Wage-Proﬁt Relationships (1987 —2000).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| r | 1/pF | | | | | |
| 1987 | 1990 | 1992 | 1995 | 1997 | 2000 |
| 0.00 | 1.868 | 1.929 | 2.103 | 2.065 | 2.096 | 2.062 |
| 0.05 | 1.685 | 1.729 | 1.867 | 1.825 | 1.854 | 1.813 |
| 0.10 | 1.518 | 1.546 | 1.649 | 1.604 | 1.631 | 1.582 |
| 0.15 | 1.365 | 1.376 | 1.447 | 1.399 | 1.425 | 1.367 |
| 0.20 | 1.223 | 1.219 | 1.258 | 1.208 | 1.232 | 1.166 |
| 0.25 | 1.093 | 1.071 | 1.080 | 1.028 | 1.051 | 0.976 |
| 0.30 | 0.971 | 0.932 | 0.911 | 0.858 | 0.879 | 0.796 |
| 0.35 | 0.857 | 0.799 | 0.751 | 0.696 | 0.715 | 0.622 |
| 0.40 | 0.750 | 0.672 | 0.596 | 0.540 | 0.557 | 0.454 |
| 0.45 | 0.648 | 0.548 | 0.445 | 0.389 | 0.404 | 0.290 |
| 0.50 | 0.552 | 0.426 | 0.298 | 0.241 | 0.252 | 0.128 |
| 0.55 | 0.460 | 0.304 | 0.152 | 0.095 | 0.102 |  |
| 0.60 | 0.371 | 0.179 | 0.006 |  |  |  |
| 0.65 | 0.285 | 0.050 |  |  |  |  |
| 0.70 | 0.201 |  |  |  |  |  |
| 0.75 | 0.117 |  |  |  |  |  |
| 0.80 | 0.034 |  |  |  |  |  |
| gmax | 0.820 | 0.668 | 0.602 | 0.582 | 0.583 | 0.539 |

Table 5. The Proﬁt Rate and Real Wage Rate in Chinese Economy

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(1987 —2000).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1987 | | | 1990 | 1992 | 1995 | 1997 | 2000 |
| Proﬁt rate Real wage rate | r\*    1  p\*\* F  1  p\* F  1  p\* F\* | 0.216  1.182  0.874  0.748 | 0.119  1.479  1.281  1.116 | 0.291  0.941  0.190  0.160 | 0.215  1.152  0.582  0.521 | 0.203  1.223  0.719  0.634 | 0.194 1.191 0.546 0.478 |

|  |  |  |
| --- | --- | --- |
| Real Wage Rate | 2.0  1.5  1.0  0.5  0.0 | Short−run  Long−run  (0.216, 1.182)  (0.216, 0.874)  (0.216, 0.748) |

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

Profit Rate

Fig. 2. The Wage-Proﬁt Curve a` la von Neumann-Leontief (1987).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Real Wage Rate | 2.0  1.5  1.0  0.5  0.0 | |  |  | | --- | --- | | (0.119, 1.116)  (0.119, 1.479)      (0.119, 1.281) | Short−run Long−run | |  | |

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

Profit Rate

Fig. 3. The Wage-Proﬁt Curve a` la von Neumann-Leontief (1990).

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|  |  |  |
| --- | --- | --- |
| Real Wage Rate | 2.0  1.5  1.0  0.5  0.0 | Short−run  Long−run  (0.291, 0.941)  (0.291, 0. 190)  (0.291, 0. 160) |

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

Profit Rate

Fig. 4. The Wage-Proﬁt Curve a、la von Neumann-Leontief (1992).

|  |  |  |
| --- | --- | --- |
| Real Wage Rate | 2.0  1.5  1.0  0.5  0.0 | Short−run  Long−run  (0.215, 1.152)  (0.215, 0.582)  (0.215, 0.521) |

0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

Profit Rate

Fig. 5. The Wage-Proﬁt Curve a、la von Neumann-Leontief (1995).

The estimated proﬁt rate and real wage rate of the Chinese economy are shown in [Table 5](#_bookmark34).

The coordinates of the estimated position of the actual Chinese economy are indicated with “⊕” in the ﬁgures of the wage-proﬁt curves.

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|  |  |
| --- | --- |
| 2.0  Real Wage Rate  1.5  1.0  0.5  0.0  Fig. 6. | Short−run  Long−run  (0.203, 1.223)  (0.203, 0.719)  (0.203, 0.634)  0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8  Profit Rate  The Wage-Proﬁt Curve a、la von Neumann-Leontief (1997). |

|  |  |
| --- | --- |
| Real Wage Rate  Fig. | 2.0  1.5  1.0  0.5  0.0  Short−run  Long−run  (0.194, 1.191)  (0.194, 0.546)  (0.194, 0.478)  0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8  Profit Rate  7. The Wage-Proﬁt Curve a、la von Neumann-Leontief (2000). |

CONCLUDING REMARKS

In this chapter, we estimated China’s marginal ﬁxed capital coefﬁcient by means of the Sraffa —Fujimori method and computed the economy’s wage- proﬁt curves in a von Neumann-Leontief system.

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The following points concerning the Chinese economy are clearly seen from the 1980s through the 2000s from our computation of theoretical parameters.

(1) The short-run maximum proﬁt rate and the long-run maximum poten- tial growth rate tends to decrease over the period.

(2) The maximum real wage rate increased over the period, both short- and long-run, although slight ﬂuctuations are observed.

(3) As the rate of proﬁt increases, the long-run wage-proﬁt curves tend to sink faster than the case of short run in each year.

(4) The marginal capital-output ratio has increased.

In this chapter, various theoretical restrictions, such as physical durabil- ities of ﬁxed capital with constant efﬁciency, etc., exist. However, estimat- ing theoretical values by using actual data, and further making simulations revealed signiﬁcance of ﬁxed capital data for better understanding of the performance of the actual economy.

In view of Government’s policy to raise wages during period concerned, it is expected that the real wages have been increasing monotonically. However, [Table 5](#_bookmark34) shows only the rising tendency. This should be investi- gated further in near future.

NOTES

1. As for Sraffa’s joint-production system with ﬁxed capital and the Leontief system with brand-new ﬁxed capital, see [Fujimori (1982)](#_bookmark35) and [Li-Fujimori (2013)](#_bookmark36).

2. The analysis frameworks on linear programming of the von Neumann, Marx, Leontief models are pioneered by Morishima (1964, 1973), [Fujimoto (1975)](#_bookmark37), Steedman (1976), and Fujimori (1982, 1992). Especially, on a premise to deﬁne the depreciation rate by the pension method, [Fujimori (1992)](#_bookmark38) expanded the joint- production model of [Morishima (1964)](#_bookmark39) and [Fujimoto (1975)](#_bookmark40), and made an abridge- ment of the linear programming model only consisting of brand-new goods by a kind of rational operation. In addition, for the other empirical contributions, see for example, [Han and Schefold (2006)](#_bookmark41).

3. In a linear multisector framework with equilibrium production prices and activity levels (or quantities) including ﬁxed capital, it is like Marx in the sense to analyze the establishment of the uniform proﬁt rate on the premise of the wage payment in advance, and it is like Sraffa in the sense to analyze them in a joint- production system including aged ﬁxed capital. So we can call this framework as the Marx —Sraffa model in a narrow sense. For a speciﬁc joint-production system, see for example, [Schefold (1989](#_bookmark42), Part II, B, §2), and for more general joint- production systems a、la Marx— Sraffa, see [Li-Fujimori (2013)](#_bookmark43).

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4. We can see the same deﬁnition of rate of depreciation in [Fujimori (1982](#_bookmark44),

p. 39). In fact, [Eq. (3)](#_bookmark9) that shows the rate of depreciation is the same as Fujimori (1992, Eq. 5, p. 44) and [Sraffa (1960](#_bookmark45), p. 65). Namely, the following expression of relation is satisﬁed.

ψi ðrÞ =  ð1+ rÞh ! 

where τi stands for the durability of the type i of ﬁxed capital. [Eq. (3)](#_bookmark9) is the deﬁnition of depreciation rate of brand-new (zero-age) ﬁxed capital.

5. For a detailed discussion, which includes ﬁxed capital, see [Fujimori (1982)](#_bookmark46), [Schefold (1989](#_bookmark47), Part II), [Kurz-Salvadori (1995](#_bookmark48), chapter 7).

6. It should be noted here that γi(g) = γi(r). In an economy that disregards non- productive consumption, the uniform proﬁt rate r and the uniform growth rate g are equal. For details, see [Fujimori (1982)](#_bookmark49).

7. For details, see Nikaido (1960, chapter 2).

8. For details of the regula falsi method, see for example, [Traub (1964)](#_bookmark50) and [Ortega-Rheinboldt (2000)](#_bookmark51).

9. See [von Neumann (1945/1946[1937])](#_bookmark52) for details of original von Neumann Model.

10. See [Fujimoto (1975)](#_bookmark53).

11. Refer to [Fujimori (1992)](#_bookmark54) for the detailed procedure of the abridgement. [Fujimori’s (1992)](#_bookmark55) method is related to Sraffa in two ways: in the way to deal with ﬁxed capital, and in other way in the similarity between estimating the marginal ﬁxed capital coefﬁcient and drawing the wage-proﬁt curves. [Fujimori (1992)](#_bookmark56) was strongly conscious of Sraffa’s system. Incidentally, [Pasinetti (1977](#_bookmark57), chapter VI) and especially [Schefold (1980)](#_bookmark58) mentioned the conceptual difference of von Neumann model, linear programming and Sraffa system, and indeed the concept of the wage- proﬁt curve is closer to Sraffa than to von Neumann.

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