A Kaldor Matching Model of Real Wage Declines

Michael Sattinger*
Department of Economics
University at Albany
Albany, NY 12222
Email m.sattinger@albany.edu

March 18, 2003

Abstract

A model linking macroeconomic equilibrium and income distribution in balanced growth equilibria is developed as a variant to the Kaldor model of factor shares. It departs from the original Kaldor model in assuming equal saving rates and production determined by a matching process between workers and jobs. Macroeconomic equilibrium (national savings equal to investment) combines with competitive microeconomic behavior to determine the real wage and real interest rate. An increase in the ratio of national debt to employment reduces the real wage, explaining recent declines.

1. Introduction

Two of Jan Tinbergen's major concerns were the formation of optimal economic policy and the distribution of income, demonstrated in two of his major pub-

*This paper has been prepared for the conference "On the Wealth of Nations–Extending the Tinbergen Heritage," at Erasmus University, April 10-11, 2003. The author is indebted to the Institute for the Study of Labor (IZA, Bonn) for support while this paper was written. The author is further indebted to Ken Beauchemin, Betty Daniel, Martin Gervais, Joop Hartog, John Jones, Shannon Seitz, Peter Skott, Coen Teulings and participants at seminars at the University at Albany and Queens University for helpful comments. Errors and opinions are the responsibility of the author.

lications (1966, 1975). However, Tinbergen did not pursue these two concerns separately. In his consideration of economic policy, he explicitly incorporated the real wage rate as a target:

> With the further generalisation of state responsibility *total real expenditure* x of the nation, supplemented by some measure of *income distribution* may be among the targets. The simplest expression of this distribution may be the ratio Λ between wages L and total national income Y, or in other cases the ratio λ between the wage rate l and the price level p. (1966, pp. 8-9)

Tinbergen's concern with the distributional effects of macroeconomic policy is not reflected in modern treatments of macroeconomics. Perhaps because of "aprioristic policy" (1966, p. 3), economists may not believe that macroeconomic policies can affect real wage rates. This could be true if a first-best general equilibrium prevails in which policies have no net distorionary effects. But in a second-best solution generated by distortionary taxes and borrowing, policies would affect the real wage rate.

Tinbergen's inclusion of the real wage rate as a target variable is justified by recent experience. The U.S. economy in past decades has exhibited a substantial decline in the real wage relative to productivity and large changes in the real interest rate over long periods. This paper develops a model linking macroeconomic variables to factor prices and income distribution. Macroeconomic equilibrium (Aggregate Demand equal to Aggregate Supply, or national savings equal to investment) determines a relationship between the real interest rate and the ratio of unemployed to vacancies. Microeconomic equilibrium, arising from competitive determination of factor prices, determines a second relationship between the two variables. Together, macroeconomic and microeconomic equilibrium determine the real interest rate, the ratio of unemployed to vacancies, and the real wage rate in balanced growth.

The model developed is a variant of Nicholas Kaldor's Keynesian model of income distribution (1955-1956, 1957), in which equality between savings and investment is brought about by shifts between profit and labor income instead of by fluctuations in economic activity.[1] In Kaldor's approach, income distribution is partly explained by macroeconomic phenomena, and shifts of factor incomes are

[1] See discussions of Kaldor's model in G. Bertola (2000, pp. 400-498), C.E. Ferguson (1969, pp. 314-322), Luigi Pasinetti (1962), Kurt Rothschild (1993, Chapters 17-19), Sattinger (2001, pp. liii-liv), Peter Skott (1989a, 1989b), and James Tobin (1989). Kaldor's model is one of

necessary to bring about macroeconomic equilibrium. The model developed here shares with Kaldor's model the involvement of income distribution with macroeconomics and the simultaneous explanation of both distributional and macroeconomic phenomena. However, the mechanism linking macroeconomic equilibrium and income distribution is different. In Kaldor's model, full employment is assumed and an aggregate investment rate is determined exogenously by balanced growth parameters. With a greater saving rate out of profits, income shifts between profits and labor income are brought about by changes in prices relative to wage rates until the aggregate saving rate equals the required investment rate. In contrast, in the model developed here, the level of production is determined endogenously, and the saving rate is assumed to be the same for all sources of income. All variables are real, so there is no inflation to bring about changes in the wage rate relative to the price level. In Kaldor's model, there is a fixed capital to production ratio so that marginal products of factors are not defined and play no role in determining factor prices. In the model developed here, marginal contributions to production from an additional worker, an additional employer, or additional capital can be defined at the aggregate level. Competitive market forces operate to determine the real wage and real interest rate consistent with neoclassical principles.

Table 1 shows interest rate, wage, productivity and debt variables that are relevant in this paper. The data are for the U.S. in the period 1961 to 1999. The real interest rate in column 2 is measured by the average interest rate on U.S. Treasury bonds with maturity over ten years minus inflation as measured by increases in the yearly average Consumer Price Index (CPI-U). The real wage is measured by average hourly earnings in 1982 dollars for total private employment, not seasonally adjusted. Productivity is measured by the Major Sector Multifactor Productivity Index for manufacturing. Column 5 is the real wage from column 3 divided by multifactor productivity in column 4 times 100. Column 6 shows the ratio of national debt to output, measured by the Congressional Budget Office as the ratio of national debt held by the public to Gross Domestic Product. The series in Column 6 can be regarded as national debt per employed worker, divided by output per employed worker. It is then national debt per employed worker controlling for productivity changes. Column 7 shows the saving rate measured in the National Income and Product Accounts by personal savings as a percentage of personal income. There are alternative ways of measuring these variables, but

---

several approaches that involve income distribution in a macroeconomic model (see Bertola, 2000, Sattinger, 1990, and Sydney Weintraub, 1958).

the major patterns are unlikely to be affected.[2]

The data show substantial changes in factor prices over long periods of time, with no indication that they are returning to an earlier equilibrium level. The real interest rate lies between two and three percent in the first half of the 1960's, falls below one percent (and often goes negative) from 1973 to 1980, rises to between five to eight percent between 1982 and 1987, and falls back to a range of three to five percent from 1988 on. As the real interest rate falls, the real wage rises from below seven in 1961 to levels above eight from 1970 to 1979. Then as the real interest rate rises from below one percent to a 17 year period above 3 percent, the real wage falls to a level below 8. These changes are not part of business cycle models describing fluctuations around a long run equilibrium. The long run changes in the real interest rate and wage rate could potentially be explained by the episode of inflation in the 1960's and 1970's but only by abandoning views that the effects of inflation on factor prices end less than a decade after stabilization of monetary growth. Productivity also does not explain the long run and substantial changes. Increases in productivity should raise both the real interest rate and the real wage. However, the real wage declines relative to multifactor productivity, as shown in the ratio in Column 5, from 1978 on. Use of output per hour instead of multifactor productivity would result in even steeper declines in the ratio of wages to productivity. Imperfections in the measurement of productivity cannot be the explanation for the observed long run behavior of factor prices since real interest rates and real wages move in opposite directions. Other explanations are possible (e.g., capital-skill complementarity) and cannot be ruled out by these data.

[2] See Kreuger, 1999, for discussion of measurement problems.

Table 1: U.S. Factor Prices and Debt

1	2	3	4	5	6	7
Year	Real r	Real Wage	Productivity	Wage/Productivity	Debt/Output	Saving Rate
1961	2.90	6.88	68.9	.999	44.9	8.3
1962	2.95	7.07	71.6	.987	43.6	8.3
1963	2.70	7.17	73.6	.974	42.3	7.8
1964	2.85	7.33	75.7	.968	40.0	8.8
1965	2.61	7.52	77.7	.968	37.9	8.6
1966	1.75	7.62	78.0	.977	34.8	8.3
1967	1.75	7.72	77.5	.996	32.8	9.4
1968	1.06	7.89	79.9	.987	33.3	8.4
1969	0.62	7.98	80.5	.991	29.3	7.8
1970	0.88	8.03	79.2	1.014	27.9	9.4
1971	1.34	8.21	81.4	1.009	28.0	10.0
1972	2.43	8.53	84.4	1.011	27.4	8.9
1973	0.10	8.55	85.9	.995	26.0	10.5
1974	-4.02	8.28	81.3	1.018	23.8	10.7
1975	-2.12	8.12	78.9	1.029	25.3	10.6
1976	0.98	8.24	81.7	1.009	27.5	9.4
1977	0.56	8.36	82.9	1.008	27.8	8.7
1978	0.29	8.40	83.6	1.005	27.4	9.0
1979	-2.56	8.17	82.7	.988	25.6	9.2
1980	-2.69	7.78	81.3	.957	26.1	10.2
1981	2.59	7.69	81.9	.939	25.8	10.8
1982	6.03	7.68	83.3	.922	28.6	10.9
1983	7.64	7.79	85.2	.914	33.0	8.8
1984	7.69	7.80	87.8	.888	34.0	10.6
1985	7.15	7.77	89.2	.871	36.4	9.2
1986	6.24	7.81	90.7	.861	39.6	8.2
1987	5.03	7.73	93.5	.827	40.6	7.3
1988	4.88	7.69	95.2	.808	40.9	7.8
1989	3.79	7.64	93.4	.818	40.5	7.5
1990	3.33	7.52	93.3	.806	42.0	7.8
1991	3.96	7.45	92.4	.806	45.4	8.3
1992	4.52	7.41	94.0	.788	48.2	8.7
1993	3.46	7.39	94.9	.779	49.5	7.1
1994	4.81	7.40	97.3	.761	49.4	6.1
1995	4.14	7.39	99.2	.745	49.2	5.6
1996	3.80	7.43	100.0	.743	48.5	4.8
1997	4.37	7.55	103.5	.729	46.0	4.2
1998	4.09	7.75	106.3	.729	42.9	4.7
1999	3.93	7.86	109.4	.718	39.7	2.4

This paper proposes an explanation based on the link between the macroeconomic sector and microeconomic determination of factor prices. The stylized facts concerning long run relationships to be addressed by the model developed here are as follows. Over the period 1961 to 1999, the real interest rate declines, increases substantially and then declines to a level greater than at the start of the period. The real wage relative to productivity is roughly inversely related to the real interest rate, rising and then declining. These patterns occur contemporaneously with a decline in the ratio of national debt to output from 1961 to the 1970's, followed by increases. While the short run effect of budget deficits on the interest rate are well known, this paper focuses on the ratio of national debt to output in balanced growth and its effects on both the real interest rate and the real wage rate. In the model that will be developed, balanced growth of a greater national debt absorbs more savings, reducing the ratio of jobs to employment and raising the ratio of unemployed to vacancies at each interest rate. In balanced growth equilibrium, greater national debt then yields a higher ratio of unemployed to vacancies, a higher real interest rate and a lower real wage rate.

The model developed here is referred to as the Kaldor matching model to distinguish it from the original Kaldor model with unequal saving rates. There are three forms of income: labor income from wages (plus transfers from the government), entrepreneurial income, and interest from either ownership of capital needed for production or ownership of national debt. Workers meet entrepreneurs with jobs in a labor market with frictions, with the number of matches per period determined by a matching function. Section 2 develops two conditions for microeconomic equilibrium. The first, the Equilibrium Selection Condition, arises from individuals in the labor force choosing between being workers or being entrepreneurs offering jobs to workers. The second, the Entrepreneur Optimization Condition, arises from competitive wage determination by wage-posting entrepreneurs. Together, the Equilibrium Selection and Entrepreneur Optimization Conditions determine the microeconomic relationship between the real interest rate and the ratio of unemployed to vacancies. Section 3 develops the macroeconomic relationship between the the same two variables, arising from the condition that Aggregate Supply equal Aggregate Demand. Section 4 shows how microeconomic and macroeconomic equilibrium determine the ratio of unemployed to vacancies, the real interest rate and the real wage rate. The section also describes the adjustment process that moves the economy to balanced growth equilibrium. Section 5 considers whether macroeconomic policies (national debt per employed worker or the tax rate on interest income) can affect the real wage rate and derives the effects of those policies. The major conclusion is that an increase in national debt per employed worker lowers the real wage. Section 6 discusses the effects on factor prices of microeconomic policy variables (taxes on labor and entrepreneurial income and unemployment benefits). Section 7 considers whether the model provides an explanation for observed real wage declines, compares the model to the original Kaldor model, and considers extensions.

2. Microeconomic Equilibrium

2.1. Production

Production at the rate of p per period arises from a fixed proportions production function when a worker is matched with a job offered by an entrepreneur. Technological change is assumed to be absent. The job requires k units of capital. The capital depreciates at the rate δ when production is taking place so that the entrepreneur must replace capital at the rate δk as production occurs. Matches break up at a rate of γ per period, the same for all matches. Matches are formed at a rate determined by a matching function $M(U,V)$, where U is the number of unemployed and V is the number of vacancies in the labor market (see Christopher Pissarides, 2000, pp. 6-7, and Barbara Petrongolo and Pissarides, 2001, for discussions of the matching function and Eran Yashiv, 2000, for estimations). The matching function is assumed to have constant returns to scale in U and V, be an increasing, concave function of its arguments, and equal zero if either U or V is zero. As a result of the assumption of constant returns to scale, the rate of formation of matches per vacancy is $M(U,V)/V = M(U/V,1)$. Let $\theta = U/V$ and let $m(\theta) = M(\theta,1)$. Then the rate at which unemployed workers get matches is $M(U,V)/U = m(\theta)/\theta$.

Let L be the total number of individuals in the labor market, either as workers or as entrepreneurs. Let J be the number of jobs and let E be the number of current matches between workers and jobs. Assume each entrepreneur can manage N_J jobs. With these assumptions,

$$\begin{aligned} U &= L - E - J/N_J \\ V &= J - E \end{aligned} \tag{2.1}$$

In a balanced growth equilibrium, L, E, J and θ must satisfy

$$\begin{aligned} \frac{dU}{dt} &= -\frac{m(\theta)}{\theta}(L - E - J/N_J) + \gamma E + \rho L - \rho J/N_J \\ &= \rho(L - E - J/N_J) \\ \frac{dV}{dt} &= -m(\theta)(J - E) + \gamma E + \rho J = \rho(J - E) \end{aligned} \tag{2.2}$$

The conditions require that unemployment and vacancies grow at the balanced growth rate of ρ. In the first line, unemployment declines by the match rate for unemployed workers times the number of unemployed and increases by the rate of match break-ups and balanced growth additions to the labor force seeking employment. This rate of change equals the growth rate times the number of unemployed. In the second line, vacancies decline by the match rate for vacancies times the number of vacancies and increases by the rate of match break-ups and balanced growth increase in jobs. This rate of change equals the growth rate times the number of vacancies. In a balanced growth equilibrium, the unemployment and vacancy rates depend on the rate of growth of the economy, ρ, since new workers enter as unemployed and new jobs enter as vacancies. Solving 2.2 for J and E in a balanced growth equilibrium yields:

$$\begin{aligned} E &= \frac{m(\theta)N_J L}{(1+\theta N_J)(\gamma+\rho) + (1+N_J)m(\theta)} \\ J &= \frac{(\gamma+\rho+m(\theta))N_J L}{(1+\theta N_J)(\gamma+\rho) + (1+N_J)m(\theta)} \end{aligned} \tag{2.3}$$

2.2. Workers

Workers move back and forth between employment and unemployment according to a two-state Markov process with transition rates $m(\theta)/\theta$ and γ. Let W_U and W_E be the asset values for an unemployed and an employed worker, respectively. These are the expected present discounted values of future benefits of working and unemployment.[3] The asset values are derived in the standard way as in Peter Diamond (1982). The asset values satisfy

$$\begin{aligned} \beta W_U &= (1-t_w)b + (m(\theta)/\theta)(W_E - W_U) \\ \beta W_E &= (1-t_w)w + \gamma(W_U - W_E) \end{aligned} \tag{2.4}$$

[3] The asset values, added to current assets, approximate the value functions from an optimal control problem in which workers save. The error from the approximation appears to be small (Sattinger, 2003).

where β is the discount rate, b is the level of unemployment benefits, t_w is the tax rate for wages and unemployment benefits, and w is the wage rate. The discount rate is assumed to be the same for all workers and entrepreneurs and differs from the interest rate on assets. It is possible to solve the system in 2.4 for βW_U to yield

$$\beta W_U = \frac{\gamma + \beta}{\gamma + \beta + m(\theta)/\theta}(1 - t_w)b + \frac{m(\theta)/\theta}{\gamma + \beta + m(\theta)/\theta}(1 - t_w)w \tag{2.5}$$

The flow of asset value βW_U is therefore a weighted average of the benefits while unemployed and employed, with the weights differing from the unemployment and employment rates because employment is discounted from the future for an unemployed worker (Sattinger, 1985, pp. 11-12).

2.3. Entrepreneurs and Jobs

Jobs move between being vacant and being filled according to a two-state Markov process with transition rates $m(\theta)$ and γ. Let W_V and W_F be the asset values for a vacant and filled job, respectively. The asset values satisfy

$$\begin{aligned} \beta W_V &= -(1 - t_p)rk + m(\theta)(W_F - W_V) \\ \beta W_F &= (1 - t_p)(p - w - \delta k - rk) + \gamma(W_V - W_F) \end{aligned} \tag{2.6}$$

where r is the interest rate in the economy and t_p is the tax rate on entrepreneurial profits. The entrepreneur pays interest on the capital k when the job is vacant but receives a tax benefit from the loss. When filled, a job generates entrepreneurial profits at a rate equal to the rate of production p, minus the wage rate w, minus depreciation δk, minus interest payments rk. As a minimum requirement for matches to occur, output is assumed to cover depreciation, interest payments, and the minimum wage necessary to exceed unemployment benefits:

$$p - \delta k - rk - b \geq 0 \tag{2.7}$$

The system in 2.6 can be solved for the flow of asset value βW_V:

$$\beta W_V = \frac{m(\theta)}{\gamma + \beta + m(\theta)}(1 - t_p)(p - w - \delta k) - (1 - t_p)rk \tag{2.8}$$

2.4. Supply of Workers and Entrepreneurs

Individuals in the labor market are assumed to choose between being workers or entrepreneurs. Individuals choosing to be entrepreneurs can supervise N_J jobs each. Their choice is based on whether the asset value from starting as an entrepreneur, $W_V N_J$, exceeds the asset value from starting as a worker, W_U. The condition for individuals' equilibrium selection between being workers or entrepreneurs is that they should be indifferent between the two activities:

$$W_U = W_V N_J \tag{2.9}$$

This will be referred to as the Equilibrium Selection Condition. This condition can be solved for the wage rate at which it is satisfied:

$$w = \frac{N_J \Phi \left((p - \delta k - rk)m(\theta) - rk(\gamma + \beta)\right) - b\theta(\gamma + \beta)}{m(\theta)\left(N_J \Phi + 1\right)} \tag{2.10}$$

where

$$\Phi = \frac{1 - t_p}{1 - t_w} \frac{(\gamma + \beta)\theta + m(\theta)}{\gamma + \beta + m(\theta)} \tag{2.11}$$

The number of individuals in the labor market, either as workers or entrepreneurs, is assumed to be an increasing function of the flow of asset value βW_U. By 2.9, this is the same value whether a person is seeking employment as a worker or as an entrepreneur. Suppose the number of individuals in the labor market, L, is given by

$$L = (L_0)^{\rho t} H(\beta W_U) \tag{2.12}$$

where H is a monotonically increasing function, ρ is the rate of growth of the population, and t is time. (The specific form of the labor supply function in 2.12 plays no role in the determination of the equilibrium values of θ, w and r, as will be seen in following sections.) For a constant value of βW_U, the number of individuals in the labor market will grow at the rate ρ per period.

2.5. Wage Determination

Wages are assumed to be determined by the mechanism described in Sattinger (1990), later referred to as wage posting.[4] Entrepreneurs announce their wages prior to a match so that no bargaining occurs. Workers know posted wages and can direct their search towards an employer offering a greater value. By offering a higher wage, entrepreneurs can attract a higher number of applicants per period, thereby lowering the time it takes to fill a vacancy. In response to a higher

[4] See Adrian M. Masters, 1999, and Daron Acemoglu and Robert Shimer, 1999, for applications of wage posting.

wage with an entrepreneur, the number of applicants per period rises until the value of seeking employment with the entrepreneur equals the value of seeking employment elsewhere in the labor market. With this adjustment in the number of applicants as a constraint on the choice of wage, the entrepreneur maximizes its asset value W_V with respect to the wage. In equilibrium, the optimal wage for an entrepreneur equals the wage prevailing in the market, and the expected number of applicants per period for an entrepreneur's vacancy equals the ratio of unemployed to vacancies in the labor market, θ. The maximization problem of the entrepreneur ensures that the entrepreneur and worker have the same trade-offs between the wage, w, and the ratio of unemployed to vacancies, θ. This is a necessary condition for efficiency and eliminates search congestion in the model developed by Sattinger (1990).

Applying this approach in the Kaldor matching model, the worker's and entrepreneur's marginal rates of substitution between the wage and θ can be derived, set equal, and solved for the wage. This procedure yields

$$\begin{aligned} w &= \frac{(\gamma+\beta+m(\theta))\left(bm(\theta)+\theta m'(\theta)(p-b-\delta k)\right)}{m(\theta)\left(\gamma+\beta+m(\theta)+(1-\theta)m'(\theta)\right)} \\ &\quad+\frac{m'(\theta)(1-\theta)(p-\delta k)}{\gamma+\beta+m(\theta)+(1-\theta)m'(\theta)} \end{aligned} \tag{2.13}$$

This will be referred to as the Entrepreneur Optimization Condition.

2.6. Microeconomic Relation Between r and θ

The Equilibrium Selection Condition in 2.10 and the Entrepreneur Optimization Condition in 2.13 yield two relations among the three variables r, θ and w. For a given interest rate, the two conditions determine the wage rate and θ. Figure 2.1 shows the Entrepreneur Optimization Condition and the Equilibrium Selection Condition for two alternative interest rates using particular parametric assumptions.[5] A feature of the Entrepreneur Optimization Condition is that it does not depend on the interest rate because r does not enter the entrepreneur's Marginal Rate of Substitution of wage rate for θ. However, a higher interest rate reduces W_V relative to W_U, so that at a given θ the wage rate must be lower for the Equilibrium Selection Condition to hold. Thus the Equilibrium Selection Condition is shifted downward for a higher interest rate. Since the Entrepreneur Optimization

[5] The figure assumes $m(\theta) = \theta/(1+\theta)$, $p = 1$, $k = 10$, $\rho = .04$, $\beta = .02$, $\gamma = .02$, $N_J = 4$, $\delta = .01$, $t_w = t_p = t_r = .1$, $b = .05$ and $D/E = .2$.

Condition stays fixed, the Equilibrium Selection and Entrepreneur Optimization Conditions generate an upward sloping relation between r and θ. This result is summarized in the following theorem.

Theorem 2.1. *In the Kaldor matching model, comparing balanced growth microeconomic equilibria satisfying the Equilibrium Selection and Entrepreneur Optimization Conditions, the interest rate is an increasing function of the ratio of unemployed to vacancies.*

This relation can be found analytically be setting the right hand side of 2.10 (the wage rate from the Equilibrium Selection Condition) equal to the right hand side of 2.13 (the wage rate from the Entrepreneur Optimization Condition) and solving for r in terms of θ. It is given by

$$\begin{aligned} r &= \frac{(p-\delta k-b)(N_J(1-t_p)(m(\theta)-\theta m'(\theta))-(1-t_w)m'(\theta))}{kN_J(1-t_p)(\beta+\gamma+m(\theta)+(1-\theta)m'(\theta))} \\ &\quad +\frac{b(1-t_w)}{kN_J(1-t_p)} \end{aligned} \tag{2.14}$$

In Section 4, this microeconomic relation will be combined with the Macroeconomic Condition for Equilibrium to determine both r and θ in balanced growth equilibrium.

An important assumption in the original Kaldor model is that the capital to output ratio is fixed so that in the absence of a marginal product of capital, the profit share is determined at a level that yields the required saving rate. With the fixed proportion production function assumed in the Kaldor matching model, the marginal product of capital in an individual match is also undefined. However, in the aggregate economy, the addition of a job (requiring a fixed amount of capital) increases the balanced growth level of employment and therefore has a well-defined marginal contribution to production. The use of a matching model in this paper does not have as its purpose the elimination of marginal products of factors. Instead, the matching technology is used because vacancies are well-defined (in the sense of a vacant job) and the description and determination of equilibrium arise conveniently in terms of the ratio of unemployed to vacancies.

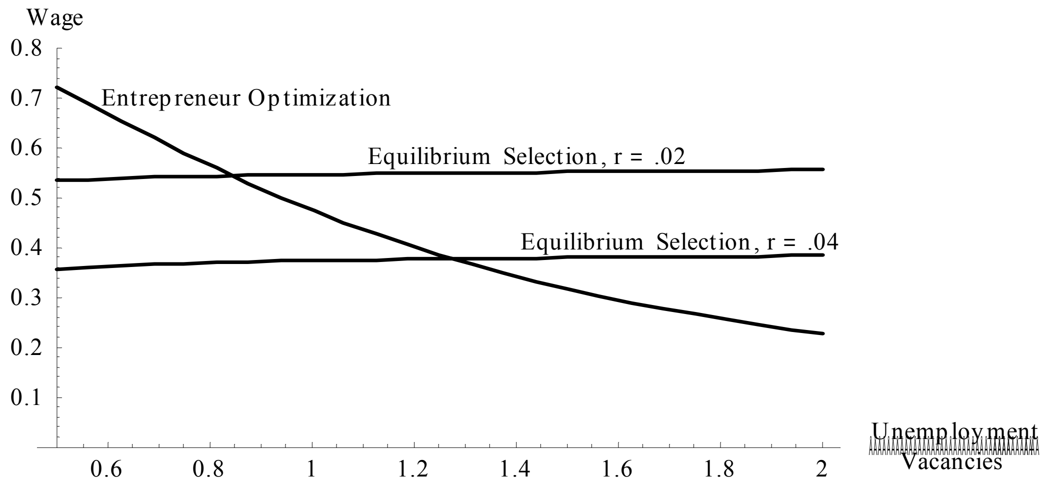

Figure 2.1: Entrepreneur Optimization and Equilibrium Selection Conditions

3. Macroeconomic Equilibrium

3.1. Government

The government taxes labor income, entrepreneurial income and interest income at potentially different tax rates, pays interest at the rate r on the national debt, pays unemployment compensation, expands the national debt at the balanced growth rate ρ, perhaps runs a deficit or surplus beyond the balanced growth expansion, and distributes the residual in the form of transfers to individuals in the economy. The government's budget constraint can therefore be expressed as

$$T + \rho D = rD + B + R + bU \tag{3.1}$$

where T is the amount of taxes collected, D is the national debt, B is the budget deficit or surplus net of balanced growth changes, R is the level of transfers, and bU is the amount paid out in unemployment benefits. In a balanced growth equilibrium, $B = 0$.

Labor income consists of wages, Ew, plus transfers, R, plus unemployment benefits, bU, which are all taxed at the same rate t_w. Entrepreneurial income is $E(p - w - \delta k) - Jrk$, which is output net of wages and depreciation for filled jobs minus the interest cost of capital incurred for jobs. Entrepreneurial income is taxed at the rate t_p. Interest income is given by $Jrk + rD$ and is taxed at the rate t_r. Total taxes in the economy are given by

$$T = t_w(Ew + R + bU) + t_p(E(p - w - \delta k) - Jrk) + t_r(Jrk + rD) \tag{3.2}$$

Rearranging 3.1 assuming $B = 0$ yields

$$R = T + (\rho - r)D - bU \tag{3.3}$$

Substituting T from 3.2 and solving for R yields

$$R = \frac{1}{1 - t_w} \begin{pmatrix} E(w(t_w - t_p) + pt_p - \delta k) - (1 - t_w)bU \\ +Jrk(t_r - t_p) + D(\rho - r(1 - t_r)) \end{pmatrix} \tag{3.4}$$

When this expression is used for R in Aggregate Demand, the government budget constraint is automatically satisfied.

3.2. Aggregate Demand

Income Y is the sum of labor, entrepreneurial and interest income:

$$Y = Ew + bU + R + E(p - w - \delta k) - Jrk + Jrk + rD \tag{3.5}$$

Assume that the saving rate out of after-tax income is a function $s(r)$ of the interest rate r. The saving rate is assumed to be the same for all levels of income and all types of income, unlike Kaldor's original model. Aggregate Demand, AD, is then the proportion of after-tax income that is not saved, $(1 - s(r))(Y - T)$, plus depreciation, $E\delta k$, plus investment needed for balanced growth, ρJk :

$$AD = (1 - s(r))(Y - T) + E\delta k + \rho Jk \tag{3.6}$$

Substituting Y from 3.5, T from 3.2, and R from 3.4 yields:

$$AD = E((1 - s(r))p + s(r)\delta k) + \rho(1 - s(r))D + \rho Jk \tag{3.7}$$

3.3. Conditions for Macroeconomic Equilibrium

Aggregate Supply minus Aggregate Demand can be found by subtracting AD from Ep :

$$AS - AD = Es(r)(p - \delta k) - \rho D(1 - s(r)) - \rho Jk \tag{3.8}$$

The notable feature of this expression for $AS - AD$ is that tax and transfer variables b, t_w, t_p and t_r do not directly appear. This occurs because transfers R are the residual of government revenues net of unemployment benefits and the saving rate $s(r)$ is the same for all income types. The tax and transfer variables then redistribute production among income types, all of which have the same saving rate, without affecting the difference between aggregate supply and aggregate demand. The variables may affect W_U and L, but E, J and D will all be proportional to L in balanced growth, so that E, J and D are sufficient to determine $AS - AD$. Interest rate payments for capital and on national debt also drop out of 3.8 for the same reasons, but the interest rate enters through its effect on the savings rate, $s(r)$.

In macroeconomic equilibrium, Aggregate Supply equals Aggregate Demand, so $AS - AD = 0$. This condition can also be viewed as stating that in balanced growth macroeconomic equilibrium, national savings, $Es(r)(p-\delta k)-\rho D(1-s(r))$, equals investment, ρJk. Setting $AS - AD$ equal to zero and dividing by E yields a condition on the ratio of jobs to employment:

$$\frac{J}{E} = \frac{s(r)(p-\delta k)}{\rho k} - \frac{1-s(r)}{k}\frac{D}{E} \tag{3.9}$$

Equality between AS and AD determines J/E (given the savings rate $s(r)$) because national savings (for a given ratio of national debt to employment) depends on E while investment in balanced growth depends on J. The ratio J/E must exceed one for vacancies to be positive. For this to occur in a balanced growth equilibrium, the following national debt constraint must hold:

$$\frac{D}{E} < \frac{s(r)(p-\delta k)}{\rho(1-s(r))} - \frac{k}{1-s(r)} \tag{3.10}$$

Now consider the relation between the ratio of jobs to employment and the ratio of unemployed to vacancies. Divide the second equality of 2.2 by E and rearrange to get

$$\frac{J}{E} = \frac{\gamma+\rho}{m(\theta)} + 1 \tag{3.11}$$

Since $m(\theta)$ is an increasing function of θ, the ratio of jobs to employment, J/E, is a decreasing function of θ. Combining 3.9 and 3.11 yields the condition for Macroeconomic Equilibrium in balanced growth:

$$\frac{1}{m(\theta)} = \frac{s(r)(p-\delta k) - \rho(1-s(r))D/E - \rho k}{(\gamma+\rho)\rho k} \tag{3.12}$$

The condition for Macroeconomic Equilibrium yields a relationship between the ratio of unemployed to vacancies, θ, and the saving rate. Regarding the saving rate as a function of the interest rate, the condition yields a relationship between θ and r. Features of this relationship are provided in the following theorem.

Theorem 3.1. *In the Kaldor matching model, with the national debt constraint holding, balanced growth macroeconomic equilibrium determines the ratio of unemployed to vacancies as a decreasing function of the saving rate in 3.12. If the saving rate is an increasing function of the interest rate, the interest rate will be a decreasing function of the ratio of unemployed to vacancies. For a given saving rate, θ is greater for greater values of ρ, δ, k, and D/E and smaller for greater values of p.*

Proof. From 3.9, an increase in $s(r)$ raises J/E and from 3.11, a higher value of J/E yields a lower value of θ. If $s'(r) > 0$, a higher interest rate raises the saving rate, reducing θ. From 3.9, higher values of δ, k and D/E and lower values of p yield lower ratios J/E and higher values of θ. By differentiation of 3.12, a higher growth rate ρ yields a higher ratio θ, and a higher separation rate γ also yields a higher θ, completing the proof.

3.4. The Saving Rate

In this section, a relation between savings and the interest rate is specified that is consistent with intertemporal optimization. Although the Kaldor matching model can be worked out for an arbitrary savings function $s(r)$, a relation consistent with intertemporal optimization will demonstrate that the results are not generated by departures from optimizing behavior.

Consider an individual with time-separable instantaneous utility of consumption given by the logarithm of consumption. Suppose the individual has a discount rate β and receives an after-tax return on assets of $(1 - t_r)r$. Then the solution to the individual's infinite horizon continuous time optimal control consumption-saving problem is to set consumption at each instant equal to $\beta/((1 - t_r)r)$ times income. The saving rate is then

$$s(r) = 1 - \frac{\beta}{(1 - t_r)r} \tag{3.13}$$

With the saving rate given by 3.13, the macroeconomic relation between the

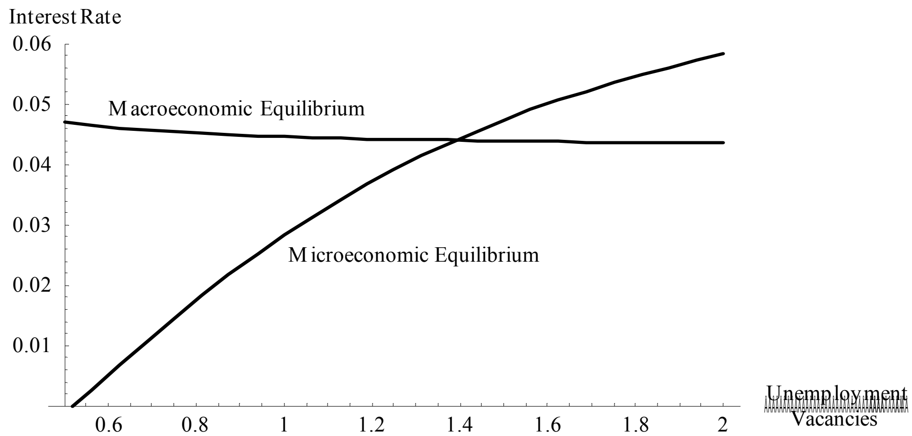

Figure 4.1: Balanced Growth Equilibrium

interest rate and the ratio of unemployed to vacancies is given by:

$$r = \frac{\beta(p - \delta k + \rho D/E)m(\theta)}{(1 - t_r)((p - \delta k + \rho k)m(\theta) - \rho k(\gamma + \rho))} \tag{3.14}$$

The effects of macroeconomic policies on factor prices are sensitive to assumptions regarding the saving rate. Alternatives will be considered in Section 5.1.

4. Balanced Growth Equilibrium

Determination of the economy's balanced growth equilibrium from the separate Microeconomic and Macroeconomic Conditions is shown in Figure 4.1, which uses the same assumptions as for Figure 2.1.[6] In Figure 4.1, the combinations of r and θ lying on the upward-sloping Microeconomic Equilibrium curve yield the equal wages from the Equilibrium Selection and Entrepreneur Optimization Conditions. Combinations of r and θ lying on the downward-sloping Macroeconomic Equilibrium curve satisfy 2.14 and yield equality between Aggregate Supply and Aggregate Demand.

[6] The equilibrium ratio of unemployed to vacancies is 1.39 and the equilibrium interest rate is .044.

A combination of r and θ satisfying both the Microeconomic and Macroeconomic Conditions is unique since the microeconomic relation is upward sloping (from Theorem 2.1) and the macroeconomic relation is downward sloping (from Theorem 3.1). Existence depends on parameter values and arises if the interest rate from the microeconomic relation starts below the interest rate from the macroeconomic relation (at low levels of θ) and then goes above the interest rate from the macroeconomic relation as θ increases.

It is routine to work out comparative static effects of parameter changes through their effects on the microeconomic or macroeconomic relations. Of particular interest is the result that a higher growth rate ρ shifts the macroeconomic relation to the right, raising r and θ. If the macroeconomic relation is relatively flat, as shown in Figure 4.1, the effects will be moderate.

Although dynamics will be deferred to a later paper, the mechanisms that bring the economy to the balanced growth equilibrium illustrated in Figure 4.1 can be briefly described. Microeconomic adjustment of θ for a given r is shown in Figure 4.2 using the same assumptions as Figures 2.1 and 4.1. The upward sloping line shows combinations of asset values W_U and W_V that satisfy the Equilibrium Selection Condition. The condition implies that the slope is N_J since $W_U = W_V N_J$. The downward sloping curve labeled Entrepreneur Optimization Condition shows combinations of W_U and W_V generated by varying θ, with the wage determined by the Entrepreneur Optimization Condition in 2.13 and the interest rate fixed at the equilibrium level, $r = .044$. A higher ratio of unemployed to vacancies benefits entrepreneurs and harms workers, so the curve slopes downward with higher values of θ yielding combinations further to the right. At θ_1, $W_U > W_V N_J$, leading entrepreneurs to switch to being workers and raising θ. This moves the ratio θ in the direction of the value satisfying both the Entrepreneur Optimization and Equilibrium Selection Conditions, at E. Analogously at θ_2, $W_U < W_V N_J$ and θ decreases towards the equilibrium value at E.

Macroeconomic adjustment of the interest rate occurs through a loanable funds mechanism as shown in Figure 4.3, which uses the same assumptions as Figures 2.1 and 4.1. For a given θ, investment per worker is determined as $\rho kJ/E$, an amount independent of the interest rate. Investment then appears as a verticle line in Figure 4.3. National savings per worker, $s(r)(p - \delta k) - \rho(1 - s(r))D/E$, is the upward sloping curve in the figure. Investment and national savings depend on θ, but θ is taken as given in the macroeconomic adjustment process. At a low interest rate, r_1, investment exceeds national savings and the interest rate rises towards the level consistent with macroeconomic equilibrium, at E. At a

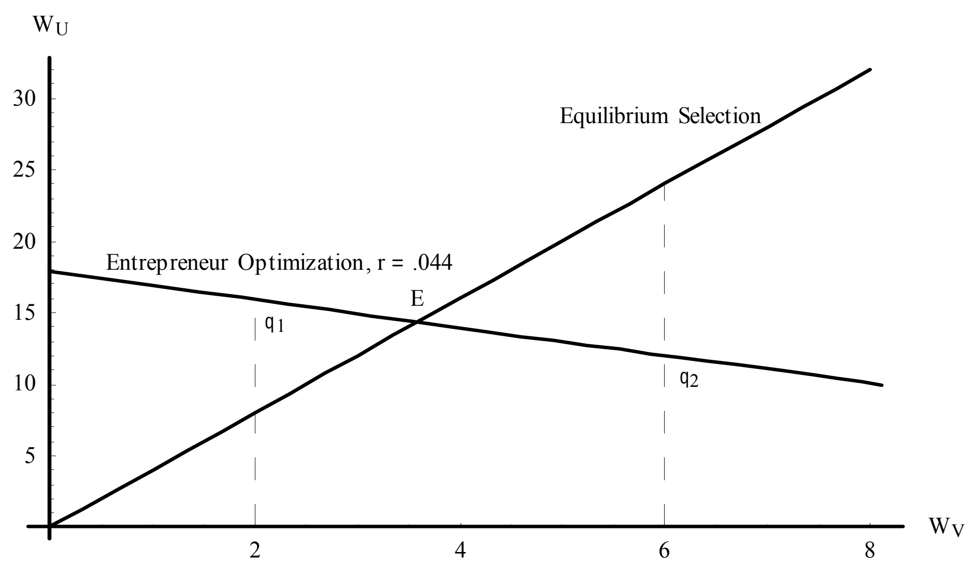

Figure 4.2: Microeconomic Adjustment of Unemployed to Vacancy Ratio

high interest rate, national savings exceeds investment and the interest rate falls towards E.

With these mechanisms, both θ and r adjust towards levels satisfying conditions for microeconomic and macroeconomic equilibrium in balanced growth.

5. Macroeconomic Policy

5.1. Can Macroeconomic Policies Affect Real Wages?

Prior to deriving the effects of macroeconomic policies on wages and the interest rate, this section considers whether there are alternative assumptions or phenomena that would rule out such cross effects, creating a dichotomy between microeconomic and macroeconomic policies.

5.1.1. Ricardian Equivalence

Macroeconomic and microeconomic equilibrium interact only through the ratio of unemployed to vacancies and the interest rate, via its effect on the saving rate. Microeconomic policy variables t_w, t_p and b drop out of the expression for macro-

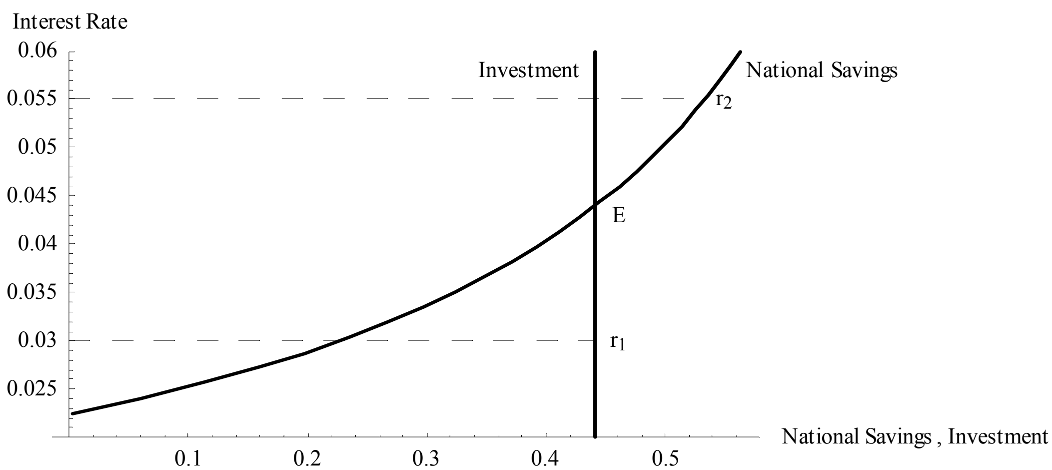

Figure 4.3: Macroeconomic Adjustment of Interest Rate

economic equilibrium in 3.12; macroeconomic policy variables D/E and t_r do not appear in the expressions for microeconomic equilibrium in 2.14. Macroeconomic policy variables therefore do not shift the microeconomic equilibrium curve in Figure 4.1, and microeconomic policy variables do not shift the macroeconomic equilibrium curve.

However, wages and interest rates are affected if macroeconomic policies shift the macroeconomic equilibrium curve. A shift in the macroeconomic equilibrium curve will not occur if savings are perfectly elastic at a fixed interest rate or if the savings function changes in a way that exactly compensates for the macroeconomic policy change, insulating the microeconomic sector from macroeconomic policy variables. To consider the latter case, rearrange 3.9 to yield the saving rate at which AD equals AS :

$$s(r) = \frac{\rho kJ/E + \rho D/E}{p - \delta k + \rho D/E} \tag{5.1}$$

Since the numerator in 5.1 is smaller, an increase in D/E requires a higher saving rate. If the saving function shifts in response to higher D/E so that the greater saving rate occurs at the former interest rate, then the macroeconomic equilibrium curve will not shift, and wages and interest rates will be unaffected by D/E.

One mechanism that could conceivably provide such a shift in the personal savings function, insulating factor prices from macroeconomic policies, is Ricardian Equivalence, which occurs when consumers disregard current tax cuts by recognizing that future tax obligations are increased. By extension, an increase in transfers generated by greater national debt would be disregarded if consumers expect taxes to increase in the future. However, only balanced growth equilibria are being compared in the Kaldor matching model. In an equilibrium with a higher debt to employment ratio, taxes will not be raised over time to pay for the greater debt. Ricardian Equivalence therefore provides no basis for a shift in the savings function that leaves the macroeconomic equilibrium curve unchanged.[7]

5.1.2. Policy Rule

A second mechanism is a policy rule to adjust the tax rate on interest income, t_r, in response to changes in the national debt to employment ratio, D/E. Setting the saving rate in 5.1 equal to the right hand side of 3.13 and solving for t_r yields

$$t_r = 1 - \frac{b(p - \delta k + \rho D/E)}{r(p - \delta k + \rho k J/E)} \tag{5.2}$$

If the tax rate on interest income is set according to the rule in 5.2 (holding r fixed), then a change in D/E yields no change in the interest rate at each ratio θ, so that the macroeconomic equilibrium curve does not shift.

5.1.3. Constant Saving Rate

In Kaldor's original model, the saving rates for different types of income were unequal but constant. If the saving rate does not depend on the interest rate, macroeconomic equilibrium would determine the ratio of unemployed to vacancies, and the microeconomic conditions then would determine the real wage and real interest rate. An increase in national debt would require a lower ratio of jobs to employment and a higher ratio of unemployed to vacancies. The macroeconomic equilibrium curve would be a vertical line and would shift right when national debt increased. Macroeconomic policies would then continue to affect factor prices.

[7] This conclusion is limited to comparisons among balanced growth equilibria. In response to business cycles or movement from one equilibrium to another, Ricardian Equivalence could apply.

5.1.4. Savings Determined by Bequests

Assuming growth in the population and labor force arises from the progeny of the current population, a bequest motive could lead wealth owners to transfer wealth to progeny. If wealth owners transfer amounts that leave new individuals with the same amounts as the owners, the total amount transferred would be $\rho D + \rho Jk$. Suppose this bequest motive is the only reason for saving and that the ratio of wealth to income is the same for all individuals in the population. Then the saving rate would be

$$s_b = \frac{\rho D + \rho Jk}{E(p - \delta k) + \rho D} \tag{5.3}$$

National savings would be

$$s_b(E(p - \delta k) + \rho D) - \rho D = \rho Jk \tag{5.4}$$

so national savings would equal investment for all values of D/E. Real wage and interest rates would be determined by microeconomic equilibrium, unaffected by D/E or t_r. The tax on interest income would fall completely on interest recipients.

5.1.5. Bequests Combined with Optimal Savings

The saving rate considered in 5.3 requires that new members of the population receive wealth equal to current members, that wealth be distributed in exact proportion to income, and that the saving rate depend only on the ratio of bequests to income and not on the interest rate. A less restrictive alternative is to suppose that savings arise from optimal saving out of after-tax income net of bequests. This assumption does not require that wealth be proportional to income for all individuals. With bequests equal to $\rho D + \rho Jk$, national savings would be

$$\begin{aligned} & s(r)(Y - T - Bequests) + Bequests - \rho D \qquad (5.5) \\ = & \left(1 - \frac{\beta}{r(1 - t_r)}\right)(E(p - \delta k) + \rho D - (\rho D + \rho Jk)) + (\rho D + \rho Jk) - \rho D \end{aligned}$$

Then national savings would not depend on national debt, and national savings would equal investment when $s(r) = 0$. A zero saving rate occurs when $r(1-t_r) = \beta$. With this savings behavior, the real wage and interest rates are unaffected by D/E. The after-tax interest rate would always equal the discount rate β, so both the real wage and interest rates would still depend on t_r.

5.1.6. Capital Proportional to Employment

In the model developed here, entrepreneurs pay interest on the capital for a job whether the job is filled or vacant. As an alternative, it could be assumed that entrepreneurs only need capital when a job is filled.[8] Balanced growth then requires investment of ρEk instead of ρJk, so that macroeconomic equilibrium is unaffected by the ratio of unemployed to vacancies, θ. The condition for Aggregate Demand equal to Aggregate Supply becomes

$$s(r)\left(p - \delta k + \rho D/E\right) - \rho D/E = \rho k \tag{5.6}$$

This condition determines the interest rate, which then determines the wage rate and θ in microeconomic equilibrium. In Figure 4.1, the curve for macroeconomic equilibrium would be a horizontal line at the interest rate determined by 5.6. A change in the ratio of national debt to employment, D/E, will continue to affect the real wage through its effect on the interest rate.

In summary, wage and interest rates will be unaffected by macroeconomic policy (either national debt or the tax rate on interest income) if the saving rate is determined entirely by the bequest motive or if the government follows the policy rule in 5.2, setting a lower tax on interest income if national debt is higher. If savings were determined by the optimal saving rate out of after-tax income net of bequests, the real wage would be unaffected by the ratio of national debt to employment but would continue to be affected by the tax rate on interest income.

5.2. National Debt

Now consider the effects of the ratio of national debt to employment, D/E, on wage and interest rates when the saving rate is determined by $s(r)$ in 3.13 (or some other upward sloping function of the interest rate) and the tax on interest income is held fixed. From 3.8,

$$\frac{AS - AD}{E} = s(r)(p - \delta k) - \rho(1 - s(r))D/E - \rho kJ/E \tag{5.7}$$

A higher value of D/E reduces national savings, yielding $AS < AD$ at the former values of r, $s(r)$ and J/E. In Figure 4.2, the curve for national savings shifts left. Then the interest rate rises, raising the saving rate and lowering AD at each ratio

[8] Pissarides (2000, pp. 23-26) uses this assumption to incorporate capital into a matching model of unemployment.

θ. Thus the curve for macroeconomic equilibrium in Figure 4.1 is higher for higher values of D/E. Combined with the microeconomic equilibrium curve, the higher macroeconomic equilibrium curve yields a higher ratio θ and a higher interest rate. From Figure 2.1 (or 2.13 and 2.10), the higher interest rate and higher θ yield a lower wage rate.

5.3. Tax on Interest Income

A positive tax on interest income, t_r, reduces the net interest rate available to savers. A higher tax on interest income therefore reduces the saving rate at each interest rate. At each θ, macroeconomic equilibrium occurs at a higher interest rate. In Figure 4.2, national savings shifts upward when t_r is higher. In Figure 4.1, the macroeconomic equilibrium curve is higher when t_r is higher. Then θ and r are higher, and the wage rate satisfying the Entrepreneur Optimization Condition and Equilibrium Selection Condition must be lower.

These results are summarized in the following theorem.

Theorem 5.1. *Suppose the saving rate is an increasing function of the interest rate and the tax on interest income is not given by the policy rule in 5.2. In the Kaldor matching model, comparing alternative balanced growth equilibria, a higher ratio of national debt to employment, D/E, or a higher tax on interest income, t_r, yields a higher ratio of unemployed to vacancies, a higher interest rate, and a lower wage rate.*

Figure 5.1 shows the effects of national debt on the wage rate, using the saving rate in 3.13 and other particular assumptions.

5.4. Effects on Asset Values

The effects of macroeconomic policy variables on the asset values W_U and W_V can be determined from the results of Theorem 5.1. The asset value for unemployed workers, W_U, unambiguously decreases from an increase in D/E or increase in t_r since the increase in θ and decrease in w both reduce W_U in 2.5 and the interest rate r does not appear in that expression. Since $W_U = W_V N_J$ from the Equilibrium Selection Condition, the asset values W_U and W_V must move together. Thus W_V also decreases, despite the decrease in the wage rate and increase in θ. Further, since W_U declines when D/E or t_r go up, the labor force $L(W_U)$ will also decrease, reducing the level of economic activity.

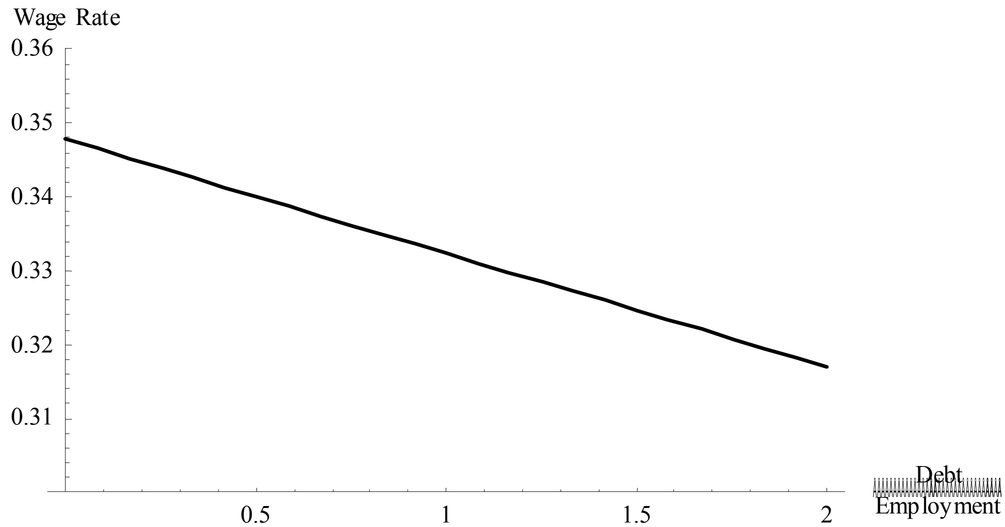

Figure 5.1: National Debt and Wage Rate

6. Microeconomic Policy

The effects of microeconomic policies t_w, t_p and b can also be determined using the Kaldor matching model. All three policy variables enter the Equilibrium Selection Condition, but only b enters the Entrepreneur Optimization Condition.

6.1. Taxes on Labor and Entrepreneurial Income

A higher t_w or lower t_p yields a higher Φ in 2.11. Then in the Equilibrium Selection Condition in 2.10, a higher Φ raises the wage rate at a given θ, since the numerator increases relatively more than the denominator. At a given θ, the wage rate generated by the Equilibrium Selection Condition exceeds the wage rate generated by the Entrepreneur Optimization Condition at the original interest rate. A reduction in θ brings the two wage rates into equality. Alternatively, in Figure 4.2, the increase in t_w or reduction in t_p raises the asset value of an entrepreneur with a vacancy relative to the asset value of an unemployed worker, shifting the Entrepreneur Optimization Condition curve downward and requiring an increase in θ for the given interest rate. The microeconomic equilibrium curve is therefore higher when t_w is higher or t_p is lower. From the balanced growth equilibrium shown in Figure 4.1, the interest rate r will be higher and θ will be lower. Then from the Entrepreneur Optimization Condition, the wage must be higher. Note that if $1-t_p$ and $1-t_w$ change by the same proportion, Φ remains the same and there are no effects on θ, r or w.

6.2. Unemployment Benefits

The effects of unemployment benefits, b, can be analyzed in terms of the curves for the Equilibrium Selection and Entrepreneur Optimization Conditions in Figure 2.1. In the Equilibrium Selection Condition in 2.10, an increase in unemployment benefit b reduces the wage at a given θ. In the Entrepreneur Optimization Condition in 2.13, the coefficient of b in the numerator is $m(\theta)-\theta m'(\theta)$. This is positive from the assumptions regarding the matching function.[9] Then at the former values of θ and r, the wage rate from the Entrepreneur Optimization Condition will exceed the wage rate from the Equilibrium Selection Condition, requiring an increase in θ to bring about microeconomic equilibrium at the given interest rate. The microeconomic equilibrium curve shown in Figure 4.1 therefore shifts to the right. In balanced growth equilibrium, a higher b yields a higher θ, lower interest rate r and a lower wage rate (from the Entrepreneur Optimization Condition), everything else the same.

These results for microeconomic policy variables are summarized in the following theorem.

Theorem 6.1. *In the Kaldor matching model, comparing alternative balanced growth equilibria, a higher tax on labor income, lower tax on entrepreneurial income or higher unemployment benefit will yield a lower ratio of unemployed to vacancies, higher interest rate and higher wage rate.*

7. Conclusions

This paper has focused on the effects of macroeconomic policy on the real wage and interest rates, justifying Tinbergen's inclusion of the real wage rate as a target

[9] The matching function is assumed to be homogeneous of degree one with positive derivatives when θ is positive and finite. Then $M(\theta,1)=\theta M_1(\theta,1)+M_2(\theta,1)$ and

$$m(\theta)-\theta m'(\theta)=M(\theta,1)-\theta M_1(\theta,1)=M_2(\theta,1)>0$$

variable. In the area of income distribution, the major conclusion of this paper is that the real wage and interest rate are not uniquely determined by microeconomic competitive conditions and instead can be affected by macroeconomic policies. The effect of national debt on the real wage is fairly general, as long as the saving rate is not determined by the bequest motive and the tax on interest income does not follow the insulating policy rule in 5.2. Comparing alternative balanced growth equilibria, a higher ratio of national debt to employment generates a higher real interest rate, a higher ratio of unemployed to vacancies, and a lower real wage rate. This result can explain the general patterns of the data in Table 1. When the debt to output ratio is relatively high (in the beginning and last parts of the period), the real interest rate is higher and the real wage rate is lower than in the middle period, when the debt to employment ratio is relatively low. Empirical testing of the effect of national debt will require disentangling the balanced growth relationships from short run open economy macroeconomic adjustments and shifts in savings behavior.

James Tobin (1989, p. 38) expressed three reservations concerning the original Kaldor model. The first concerned whether factor prices could be determined independently of their productivities. In the Kaldor matching model developed here, factor prices are not independent of their productivities, but also are not uniquely determined by them. For a given ratio of unemployed to vacancies, competitive behavior of workers and entrepreneurs, reflected in the Equilibrium Selection Condition and Entrepreneur Optimization Condition, determine factor prices consistent with optimizing behavior. Different values of θ, brought about by shifts in the macroeconomic equilibrium curve, then yield different real wages and real interest rates, as shown in the curve for microeconomic equilibrium. Tobin's second reservation was that the consumption function could not explain both income shares and level of output. In the Kaldor matching model, other relations (generated by the Equilibrium Selection Condition, Entrepreneur Optimization Condition and Aggregate Supply equal to Aggregate Demand) are combined with the consumption function (expressed in terms of the saving rate $s(r)$) to determine income shares and level of output in balanced growth equilibrium. While the consumption function plays a role, it is not being overburdened. Tobin's third reservation was that investment was wholly exogenous in Kaldor's original model. In the Kaldor matching model, both national savings and national investment are endogenous. National investment can vary depending on the ratio of jobs to employment. National savings can vary depending on the amount of savings absorbed by balanced growth expansion of the national debt.

This paper has only explored balanced growth links between macroeconomics and factor prices. Important extensions would explore efficient public finance and the relation between short-run changes in income distribution and macroeconomic adjustment.

Previous analyses of Kaldor's original model focused on differential saving rates, growth factors, and the absence of marginal products as the source of the results. This paper instead emphasizes the condition imposed on competitive factor price determination by macroeconomic equilibrium.

References

[1] Acemoglu, Daron and Shimer, Robert (1999), "Holdups and Efficiency with Search Frictions," *International Economic Review* Vol. 40(4), pp. 827-849.

[2] Bertola, G. (2000), "Macroeconomics of Distribution and Growth," Chapter 9, pp. 477-540, in Anthony B. Atkinson and François Bourguignon, eds, *Handbook of Income Distribution, Volume 1*, Elsevier, Amsterdam.

[3] Diamond, Peter (1982), "Wage Determination and Efficiency in Search Equilibrium," *Review of Economic Studies* Vol. 49, pp. 217-227.

[4] Ferguson, C.E. (1969), *The Neoclassical Theory of Production and Distribution*, Cambridge University Press, Cambridge.

[5] Kaldor, Nicholas (1955-1956), "Alternative Theories of Distribution," *Review of Economic Studies* Vol. 23, pp. 83-100.

[6] ——————— (1957),"A Model of Economic Growth," *Economic Journal* Vol. 67, pp. 591-624.

[7] Kreuger, Alan (1999), "Measuring Labor's Share," *American Economic Review Papers and Proceedings* Vol. 89(2), pp. 45-51.

[8] Masters, Adrian M. (1999), "Wage Posting in Two-Sided Search and the Minimum Wage," *International Economic Review* Vol. 40(4), pp. 809-826.

[9] Pasinetti, Luigi L. (1962), "Rate of Profit and Income Distribution in Relation to the Rate of Economic Growth," *Review of Economic Studies* Vol. XXIX, no. 4, pp. 267-279.

[10] Petrongolo, Barbara and Pissarides, Christopher (2001), "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature* Vol. 39, no. 2, pp. 390-431.

[11] Pissarides, Christopher (2000), *Equilibrium Unemployment Theory,* second edition, MIT Press, Cambridge.

[12] Rothschild, Kurt W. (1993), *Employment, Wages and Income Distribution*, Routledge, London.

[13] Sattinger, Michael (1985), *Unemployment, Choice and Inequality,* Springer-Verlag, Berlin.

[14] ——————(1990), "Unemployment, the Market for Interviews, and Wage Determination," *Journal of Political Economy Vol.* 98(2), pp. 356-371.

[15] —————(2001), "Introduction," in Michael Sattinger (ed), *Income Distribution,* Volume I, Edward Elgar, Cheltenham.

[16] —————(2003), "The Markov Consumption Problem," unpublished paper, University at Albany.

[17] Skott, Peter (1989a), *Kaldor's Growth and Distribution Theory*, Peter Lang Verlag, Berlin.

[18] ——————(1989b), *Conflict and Effective Demand in Economic Growth*, Cambridge University Press, Cambridge.

[19] Tinbergen, Jan (1966), *On the Theory of Economic Policy,* North-Holland Publishing Company, Amsterdam. Originally published 1952.

[20] —————(1975), *Income Distribution,* North-Holland Publishing Company, Amsterdam.

[21] Tobin, James (1989), "Growth and Distribution: A Neoclassical Kaldor-Robinson Exercise," *Cambridge Journal of Economics* Vol. 13, pp. 37-45.

[22] Weintraub, Sidney (1958), *An Approach to the Theory of Income Distribution*, Chilton Company, Philadelphia.

[23] Yashiv, Eran (2000), "The Determinants of Equilibrium Unemployment," *American Economic Review* Vol. 90, No. 5, pp. 1297-1322.