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The Structuralist Perspective on Real Exchange Rate, Share Price Level and Employment Path: What Room is Left for Money?

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The current sluggish performance of the US economy follows one of the more remarkable booms in modern history. The late 1990s was a period of simultaneous output and productivity growth,[1] low unemployment and stable inflation, culminating in an unemployment rate of only 3.9% in the fourth quarter of the year 2000. The absence of rising inflation during this period came as a surprise to many since the level of the natural rate of unemployment was commonly estimated to be in the range of 5-6% by the mid 1990s. The non-inflationary boom, however, reminds one of another episode where non-monetary forces were strongly at work, namely, the non-deflationary slump in Europe and elsewhere in the 1980s and 90s, which appeared to signal a move to a higher natural rate of unemployment. The modeling of such structural slumps and booms is the task that we have tackled in a number of papers in recent years, the book *Structural Slumps* being a major milestone.[2]

The theory set out in *Structural Slumps* models the supply side of the economy and provides microeconomic foundations for a moving natural rate of unemployment. Involuntary unemployment occurs, since incentive wages and consequent job rationing are allowed, and this unemployment is structural, not a result of deficient aggregate demand. The determining structure includes tax rates and regulations, the focus of supply-side (SS) theory, and includes fluctuations in technical progress, the focus of "real business cycle" (RBC) theory, but includes much more. The implications exhibit some sharp differences from those of Keynesian theory and some striking parallels, as we shall see.

What basically characterizes the structuralist perspective and differentiates it from RBC and SS models is its view of business life: the imperfect information, the business assets firms need and the expectations they have to form. A firm incurs costs to acquire and retain employees (workers who know their job, have learned the ropes) and customers (buyers who know how to reach it), not just equipment and plant. The rate of investment in each asset is a function of the value, or shadow price, placed by firms on that asset and the cost of investing in it. A raft of non-monetary fundamentals – world real interest rates, expectations for technical advances and thus productivity growth, entitlements, the

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[1] In 1996-2000 the rate of growth of output per man-hour in the business sector ranged between 2.3% and 3%.

[2] Edmund Phelps, *Structural Slumps: The Modern Equilibrium Theory of Unemployment, Interest and Assets*, Cambridge, Mass., Harvard University Press, 1994.

stocks of the business assets, the wealth of the workers, tax rates, the political climate, investor trust, etc. – drive the values placed on the business assets, the cost of investing in them, and thus the rates of investment in them.[3]

Our "baseline" models of business-asset investment and the employment path are restricted to the case of inter-temporal equilibrium: more accurately, to a "punctuated" equilibrium in which, infrequently or more frequently as the case may be, a wholly unforeseen shift in one or more of the fundamentals occasionally occurs – a parametric shift or even a loss of some kind of capital – causing jumps in the real values of each of the business assets onto their new correct-expectations time-paths. Yet some of the key forces among these fundamentals, such as the visions of (each of) the economy's entrepreneurs about future profit opportunities and the judgments of financiers and professional investors, are plainly speculative, unobservable, unmeasurable; moreover, the consequences of both these unobservable forces and the observable ones, such as the world real interest rate and the long-term national productivity trend, for the values (the shadow prices) entrepreneurs put on the customer, the employee and much else are likewise unobservable. This is a problem for testing and using the theory, as it was for testing and using Keynes's theory.[4]

Two recent papers of ours meet that problem by hypothesizing that the net overall influence of these unobservable forces on the assets' shadow prices (and thus on the employment path) is reflected, alongside the net influence of some related observable forces, by the level of the stock market. Since either the level of employment or its growth is an increasing function of *every one* of the (three) shadow prices, it is plausible that an increase in the current index of real share prices, interpreted as the current shadow price of the representative basket of the firms' several business assets, is also expansionary for employment on the average. The papers found a statistical relationship between the first difference of employment and the real share price index taken as a ratio to some indicator of the cost of investing in employees and customers.[5] An alternative measure of the unobservable share prices is total market capitalization as a share of GDP. The figure below shows the relationship (cross section) between market capitalization and the employment rate.

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[3] The employee model, also called the turnover-training model or quitting model, derives from Phelps, "Money Wage Dynamics and Labor Market Equilibrium," *Journal of Political Economy*, 76, August 1968. The customer model originates in Phelps and Sidney Winter, "Optimal Price Policy under Atomistic Competition," in Phelps, et al., *Microeconomic Foundations of Employment and Inflation Theory*, 1970.

[4] Keynes, whose theory gave center stage to the unpredictability and unobservability of entrepreneurs' visions and optimism, expressed skepticism that statistical analyses, such as those Jan Tinbergen began to undertake, would be valuable in forecasting employment swings or in testing his theory's explanation of them. Subsequent practicioners avoided the problem by treating investment demand as exogenous. It was not until James Tobin introduced his "Q ratio" that empirical work sought to capture the role of entrepreneurs' expectations on investment, essentially by relocating the exogeneity from investment demand to the stock market.

[5] David Jestaz, Jean-Paul Fitoussi, Edmund Phelps and Gylfi Zoega, "Roots of the Recent Recoveries: Labor Market Reforms or Private Sector Forces?" *Brookings Papers on Economic Activity*, no. 1, 2000, 237-311, and Edmund Phelps and Gylfi Zoega, "Structural Booms: Productivity Expectations and Asset Valuations," *Economic Policy*, no. 32, April 2001, 85-126.

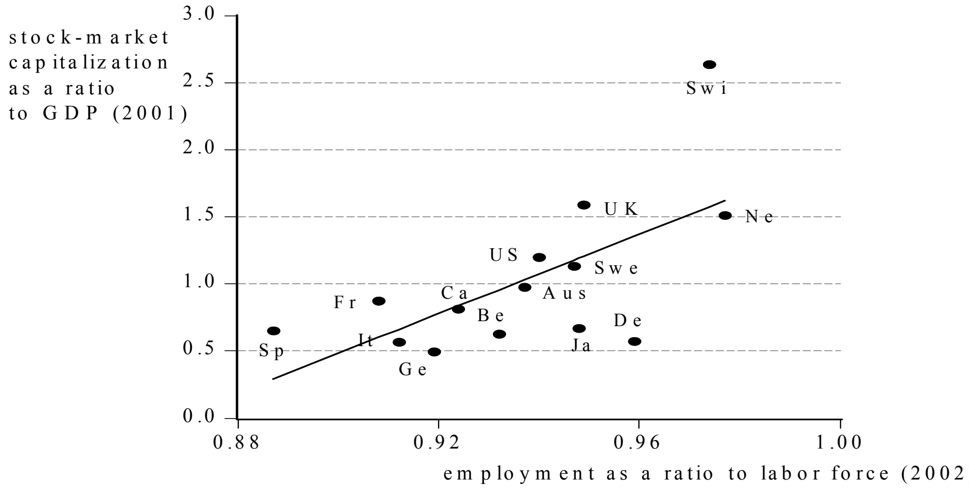

Figure 1. Employment and the Stock Market

A clear positive relationship is visible. Note that Switzerland is way off the line. The very high value of stock market capitalization in Switzerland would lead us to predict an even higher employment rate. However, in accordance with our theory, the supply function may be convex and only asymptotically approaches full employment, in which case the position of Switzerland in the figure may not come as a big surprise.

The present paper, in pursuing that strategy, faces up to some questions. First, there is another asset price, which we neglected in the two previous papers, namely, the real exchange rate. In the customer-market model, an appreciation (strengthening) of the real exchange rate in a country causes firms to moderate their price markups, thus pulling *up* the product wage and employment – an *upward* move along what is called the wage curve: the real appreciation may hence lower the natural rate of unemployment! This is the provocative hypothesis at the heart of this paper. So we ask whether employment rises in response to a strengthened real exchange rate just as it rises in response to a strengthening of real share prices. The question is especially interesting since, as is well known, monetary theories of economic activity say that the stock market and the foreign exchange market pull in opposing directions: In those Keynesian and monetarist models, a strengthening of real share prices increases economic activity by boosting “effective demand” but a strengthening (appreciation) of the real exchange rate decreases activity by cutting effective demand.[6]

Real exchange rates are typically reported in the form of indices that enable a comparison over time but not across countries. For this reason we use data from the World Bank on

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[6] Making his case for a flexible exchange rate, Milton Friedman famously argued that, to paraphrase it a little, if expected future profit prospects deteriorate and so share prices drop, thus threatening investment demand, the real exchange rate will drop just enough to offset the drop in share prices, thus holding or returning employment to some fixed preternatural level – a natural rate taken to be invariant or simply the previous employment level. The Mundell-Fleming model nicely demonstrates that proposition and the Dornbusch model modifies it.

hypothetical exchange rates that would give purchasing-power parity (PPP) between a country and the US. The ratio of this hypothetical exchange rate and the actual exchange rate – observed in foreign exchange markets – can be used to test our hypothesis on the relationship between real exchange rates and the natural rate of employment and unemployment.

In Figure 2 we show the relationship between the real exchange rate – defined as described in the previous paragraph – and the employment rate (one minus the rate of unemployment) in a cross section of the same OECD economies.

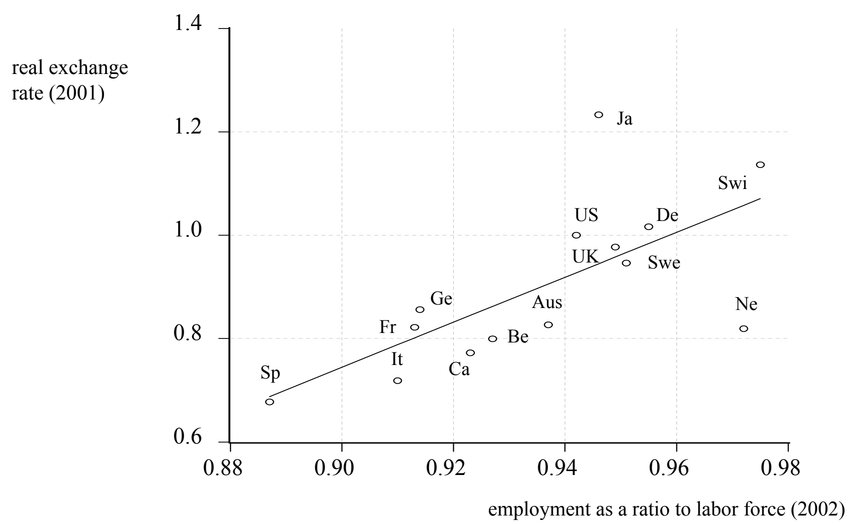

Figure 2. Employment and real exchange rates

Note the upward-sloping relationship: A real exchange rate appreciation appears to go hand in hand with higher employment rates – when domestic output becomes relatively more expensive, the rate of employment goes up, instead of falling as Keynesian theory might lead us to believe. Though not perfect, the relationship is surprisingly strong (correlation is 0.68). We take this simple graph to be indicative that the relationship between real exchange rates and employment may be more involved than the textbook version of the open-economy (New) Keynesian model would lead one to believe.

In Part I we lay out the theory and the answer to the key question whether a real exchange rate appreciation tends to raise or lower the rate of employment. Figure 2 appears to imply that a stronger real exchange rate acts to raise the employment rate. However, it is not clear whether it is the cause or the effect? After all, our model also says that a weakening of profit prospects and the consequent drop in investment and ultimately employment causes a weaker real exchange rate as well as lower real share prices. From a forecasting standpoint, this distinction makes little difference: Either way, whether as causes or effects, the strength of the real exchange rate and of the real share-price level are theory-grounded predictors of where present forces are taking the economy one or two years ahead – absent a shift in the winds. A weak real exchange rate, like a weak stock market, spells weak activity ahead.

In Part II, we consider the implications of our model for the conduct of monetary policy. Clearly, a central bank faces a daunting task during structural booms and slumps because the underlying natural rate of unemployment is changing over time. Our model yields a solution for the domestic real interest rate that is compatible with the endogenously determined natural rate of unemployment. This is the natural rate of interest, discussed by Knut Wicksell. By keeping the short-term real interest rate in tandem with the natural rate of interest, a central bank is able to control the equilibrium inflation rate and keep the economy along a path of time-varying natural rate of unemployment. The natural rate of interest could, therefore, serve as the guiding light of a central bank's interest rate policy during structural booms and slumps!

Part III examines the data and finds that a real exchange rate appreciation may raise the employment rate, hence providing support for our theoretical prediction and casting doubt on the simplest versions of the Keynesian model. The result is a rather hopeful step in the confirmation of our structuralist model. We find that a weaker real exchange rate, in sheltering firms from overseas competitors, invites higher markups – effectively, a contraction in the supply of output and jobs – which causes employment to contract, not expand as in the monetary views.

Part IV takes a look at recent US experience, in particular, it asks whether the current slump is of a structuralist nature. Again, the results are promising. The economic boom experienced in the US in the late 1990s is almost entirely explained by our model, while the petering out of that boom and the recent rise in unemployment is also to a large extent compatible with our model.

I. Theory

Here we set out a model of the small open economy in which all firms, foreign and domestic, operate in a market subject to informational frictions. We first examine a case where, initially all the relevant customers of national firms – firms that produce only with national labor – are nationals. Although the small open economy is too small, by definition, to affect perceptibly the world real rate of interest, changes in demand by its national customers will certainly be felt by national firms, and so will the exchange rate and the real interest rate in terms of the goods supplied by national firms and their price.

With regard to the *i*-th firm, we let x^i, a continuous variable, denote (the size of) its customer stock; let c^{si} denote the amount of consumer output it supplies per customer; and let p^i denote its price, say, in units of the domestic good. We will let p denote the price at the other domestic firms and p^e denote the price that the firm and its customers expect is being charged by other domestic firms (all measured in units of the domestic good). We introduce a variable e, where e tells us how many units of the foreign good must be given up in exchange for one unit of the domestic good. Consequently, an increase in e is a real exchange rate appreciation.

In product-market equilibrium, by definition, every firm and its customers have correct expectations about the other firms, that is, $p=p^e$. With their expectations thus identical in product-market equilibrium, the identically situated domestic firms will then behave alike, so that $p^i=p=p^e$.

A firm, in maximizing the value of its shares, has to strike a balance between the benefits of a high price, which are increased revenue and reduced cost, thus increased profit, in the present, and the benefits of a low price, which are an increased profit base in the future as customers elsewhere gradually learn of the firm's price advantage. The key dynamic is therefore the law of motion of the firm's customer stock,

(1) $$d x_t^i /dt=g(p_t^i /p_t,\ e_t)\, x_t^i \,;\ g_1<0;\ g_{11}\leq 0;\ g_2<0;\ g_{22}\leq 0;\ g(1,1)=0.$$

The joint assumption that $g_1<0$; $g_{11}\leq 0$ means that the marginal returns to price concessions are non-increasing, in the sense that successive price reductions of an equal amount by firm i yield a non-increasing sequence of increments to the exponential growth rate of customers. The inequality $g_2<0$ implies a gain of customers at the expense of foreign suppliers when the real exchange rate depreciates though successive weakening of the real exchange rate yields a non-increasing sequence of increments to the exponential growth rate of customers since $g_{22}\leq 0$. What the sign of g_{12} is relates to the question of what the effect of foreign competition on domestic firms' market power is. Suppose that $e<1$ so there has been a real exchange rate depreciation, hence foreign goods are selling at a premium. Then each identically situated domestic firm is increasing its market share at the expense of foreign suppliers. In such an environment, a reduction in p^i, given p, can be expected to generate a smaller increase in the rate of inflow of customers compared to a situation where $e>1$ (and each identically situated domestic firm is losing customers to foreign suppliers). Since stiffer foreign competition (higher e) confers a higher marginal return to a price concession, firm i is induced to go further in reducing its markup, holding other things constant. In our theory, therefore, the assumption that $g_2<0$; g_{22} <0 taken alone or jointly with $g_{12}<0$ implies that an appreciation of the real exchange rate will lead to lower domestic markups and hence increased output supplied due to the increased competition that domestic producers face from foreign suppliers.

It turns out that our key theoretical results below will depend on the assumption of $g_2<0$; g_{22} <0; and $g_{12}<0$. Because of this assumption, a real exchange appreciation will raise the marginal benefit of cutting domestic prices – in terms of retaining more customers – and such price cuts will appear in the labor market as upward shifts of the labor demand curve, raising employment and reducing unemployment (that is, the natural rate of unemployment). The reader may want to pause to contemplate the assumption for a few seconds. It implies that when domestic goods are relatively expensive, the marginal benefit from cutting prices – in terms of customers recruited – is greater, hence prices are lower given nominal wages, the real demand wage is higher, and so is the rate of employment in equilibrium. Intuitively, high domestic prices may have made consumers aware or suspicious of further price increases. When customers pay closer attention to price decisions, this increases the gain domestic firms reap from price cuts – in the form of an expanded market share – and the loss inflicted on the domestic market share from price increases.

The reader might wonder whether a policy of "pricing to market" might not nullify our results. If foreign producers sell their output in our market at a fixed domestic price that does not respond to changes in the (nominal) exchange rate, so the degree of exchange rate pass-through is zero, the real exchange rate will be unchanged. In contrast, when foreign producers fix the foreign price of their product, or at any rate do not change it equi-proportionately in response to a nominal exchange rate change, and allow the domestic (import) price to fluctuate, the real exchange rate is bound to fluctuate. The high correlation in the data between nominal and real exchange rates suggests that the latter scenario is by no means unrealistic so our model has applicability despite our abstracting from pricing to market behavior. The degree of exchange rate pass-through is high when (nominal) exchange rate changes are perceived to have a large permanent component.[7]

The representative firm has to choose the price at which to sell to its current customers. Raising its price causes a decrease, and lowering the price an increase, in the quantity demanded by its current customers according to a per-customer demand relationship, $D(p^i/p,c^s)$, where c^s in this context is set equal to the average expenditure per customer, c^d, at the other firms. For simplicity, we assume that $D(p^i/p,c^s)$ is homogeneous of degree one in total sales, c^s, and so we write $c^{si} = \eta(p^i/p)\, c^s$; $\eta'(p^i/p)<0$; $\eta(1)=1$. Each firm chooses the path of its real price or, equivalently, the path of its supply per customer to its consumers, to maximize the present discounted value of its cash flows. The maximum at the *i*-th firm is the value of the firm, V^i, which depends upon x^{i}:

$$V_0^i \equiv \max \int_0^\infty [(p_t^i / p_t) - \varsigma]\eta(p_t^i / p_t) c_t^s x_t^i \exp^{-\int_0^t r_s ds} dt,$$

where ς is the unit cost. The maximization is subject to the differential equation giving the motion of the stock of customers of the *i*-th firm as a function of its relative, or real, price and the real exchange rate given by (1) and an initial x_0^i. The current-value Hamiltonian is expressed as

$$[(p^i / p) - \varsigma]\eta(p^i / p) c^s x^i + q^i g(p^i / p, p^i / p^*) x^i,$$

[7] Kenneth Froot and Paul Klemperer, 1989, "Exchange Rate Pass-Through When Market Share Matters," American Economic Review, Vol. 79, No. 4, p. 637-654. Using a customer-market model similar to ours, Froot and Klemperer show that the extent of "pricing to the market" depends on the expected persistence of nominal exchange rate changes. A transient appreciation of the domestic currency may induce foreign producers to raise the domestic (import) price of their output in order to benefit further from the temporarily high value of the currency – since the future loss matters less due to the expectation that the value of the currency will be lower – while a permanent appreciation raises both the benefit and cost of raising current prices, hence leaving the foreign price unchanged, and the domestic (import) price lower.

where q^i is the shadow price, or worth, of an additional customer and p^* is the price charged by the foreign supplier expressed in our domestic currency. The first-order condition for optimal p^i is

(2) $$\eta(p^i/p)\frac{c^s x^i}{p} + [(p^i/p) - \varsigma]\eta'(p^i/p)\frac{c^s x^i}{p} +$$

$$q^i[g_1(p^i/p, p^i/p^*)\frac{x^i}{p} + g_2(p^i/p, p^i/p^*)\frac{x^i}{p^*}] = 0.$$

Another two necessary first-order conditions (which are also sufficient under our assumptions) from solving the optimal control problem are:

(3) $$dq^i/dt = [r - g(p^i/p, p^i/p^*)]q^i - [(p^i/p) - \varsigma]\eta(p^i/p)c^s,$$

(4) $$\lim_{t\to\infty} \exp^{-\int_0^t r_s ds} q_t^i x_t^i = 0.$$

We can readily show that "marginal q" is equal to "average q" so we have $q^i = V^i / x^i$.

Equating p^i to p, and setting q^i=q, delivers the condition on consumer-good supply per firm for product-market equilibrium:

(5) $1+[\eta(1)/\eta'(1)]-\varsigma = -(q/c^S)[1/\eta'(1)][g_1(1,e)+eg_2(1,e)]$; $\eta(1)=1$.

The expression on the LHS of (5) is the algebraic excess of marginal revenue over marginal cost, a negative value in customer-market models as the firm supplies more than called for by the static monopolist's formula for maximum current profit, giving up some of the maximum current profit for the sake of its longer-term interests. An increase in q means that profits from future customers are high so that each firm reduces its price (equivalently its markup) in order to increase its customer base. Hence lower prices in the Phelps-Winter model are a form of investment, an investment in market share. Note also the role played by the real exchange rate (e). If stiffer foreign competition leads to reduced market power of domestic firms, then a higher e leads domestic firms to increase their output even further beyond the point where current marginal revenue equals marginal cost as dictated by a static monopolist. This channel is present if either $g_{12}(1,e)<0$ or $g_{22}(1,e)<0$.

Alternative specifications of the labor market give rise to a unit cost ς that is a rising function of $c^s x/\Lambda$. One assumption is to suppose that there is a wage curve that is generated from a shirking view of the labor market. Another alternative is to suppose that there is a neoclassical labor supply that is positively sloped in the (employment, real wage) plane. From (5), we can express consumer-good supply per customer relative to productivity, c^S/Λ, in terms of q/Λ, e, and x, that is, $c^S/\Lambda = \Omega(q/\Lambda, e, x)$. It is straightforward to show that $0<\varepsilon_{q/\Lambda} = d\ln(c^S/\Lambda)/d\ln(q/\Lambda)<1$; $\varepsilon_e = d\ln(c^S/\Lambda)/d\ln e>0$; and

$-1 < \varepsilon_x = d\ln(c^s/\Lambda)/d\ln x < 0$, where ε_j denotes the partial elasticity of c^s/Λ with respect to the variable j. As explained before, an increase in q makes investments in customers through reducing the markup attractive and so expands output. An increase in e, that is, a real exchange rate appreciation causes markups to decrease as domestic firms face stiffer competition from foreign suppliers and consequently leads to increases in output and employment. Finally, with rising marginal costs, an increase in the number of customers at each firm leads to a less than proportionate decline in the amount of output supplied per customer. Noting that we can express the markup, say, μ as being equal to $1/\varsigma$, we can say that our theory implies that, for given x, the markup is inversely related to q/Λ and e so we write $\mu = m(q/\Lambda, e)$. Given x, there is a monotonically negative relationship between the natural rate of employment and the markup so we can write $1 - u_n = \Theta(q/\Lambda, e); \Theta_{q/\Lambda} > 0; \Theta_e > 0$. In a diagram with q/Λ and e on the two axes, the iso-$(1 - u_n)$ contour is downward sloping with a move in the North-east direction implying a move to a higher level of $1 - u_n$.

Finally we sketch the mechanisms of saving, investment and asset valuation in the capital market. Households have to plan how much of income to save, putting their savings in domestic shares; any excess is invested overseas and any deficiency implies the placement of shares overseas. Firms have to plan their accumulation of customers, issuing (retiring) a share for each customer gained (lost); any excess of customers over the domestic population implies some customers are overseas and any deficiency means that foreign firms have a share of the market. Since the stock of customers, hence shares, is sluggish, the level of the share price must clear the asset market.

In a symmetric situation across firms, (3) simplifies to

(6) $$[1 - \varsigma]\, c^s/q + (dq/dt)/q + g(1,e) = r.$$

This equation in the firm's instantaneous rate of return to investment in its stock of assets, which are customers, is an intertemporal condition of capital-market equilibrium: it is entailed by correct expectations of dq/dt, r and e at all future dates. We will make the assumption that initially all shares issued by domestic firms are held by nationals.

Drawing upon the Blanchard-Yaari model of finite-lived dynasties subject to exponential mortality, it is argued that the economy here satisfies an Euler-type differential equation in the rate of change of consumption per customer, c^d. Consumption growth is governed by the excess of the interest rate over the rate of pure time preference, denoted ρ, and by the ratio of (nonhuman) wealth, denoted W, to consumption. Upon setting customers' consumption per customer equal to the output supplied to them per customer, c^s, we obtain

(7) $$d\,c^s/dt = (r - \rho)\,c^s - \theta(\theta + \rho)W,$$

where θ denotes the instantaneous probability of death and $W = qx$ here. In requiring here that q at each moment be at such a level as to make the path of planned consumption (its growth as well as its level) consistent with the path of output from (5), we are requiring that the market where goods are exchanged for shares (at price q) be in equilibrium. No household will find the prevailing share price different from what is expected.

Finally, for international capital-market equilibrium with perfect capital mobility, we must satisfy the real interest parity condition, which states that any excess of domestic real interest rate, r, over the exogenously given world real rate of interest, r^*, must be met by an exact amount of expected rate of real exchange depreciation. This equation is:

$$(8) \qquad r = r^* - (de/dt)/e.$$

Equations (5) to (8) give us four equations in the four variables: c^s/Λ , q/Λ, e and x. However, using the relation $c^s/\Lambda = \Omega(q/\Lambda, e, x)$ derived from (5), we can reduce the system to three dynamic equations in the three variables: q/Λ, e and x, the last being a slow-moving variable. We proceed to do the necessary substitutions to obtain the 3 by 3 dynamic system but it will turn out convenient to present an analysis of a subsystem treating the state variable x as frozen at its initial value.[8] In a diagram involving q/Λ and e on the two axes and depicting the two stationary loci associated with equations (7) and (8), we can then show how an adjustment of x, in response to an economic shock, shifts the two loci to reach a sort of quasi-long run steady state where e is back to one, hence satisfying the purchasing power parity in the (quasi) long run.

A. *The 3 by 3 Dynamic System*

The dynamics of the system can be described by the behavior of the endogenous variables q/Λ, e and x after substituting out for c^s/Λ using $c^s/\Lambda = \Omega(q/\Lambda, e, x)$:

$$(9) \qquad (dq/dt)/q = [(1+ \varepsilon_e)/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]f(q/\Lambda, e, x)+ [\varepsilon_e/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]h(q/\Lambda, e, x),$$

$$(10) \qquad (de/dt)/e = [(1- \varepsilon_{q/\Lambda})/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]h(q/\Lambda, e, x)- [\varepsilon_{q/\Lambda}/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]f(q/\Lambda, e, x),$$

$$(11) \qquad (dx/dt)/x = g(1,e),$$

where

$$f(q/\Lambda, e, x) = -[1-\Upsilon(\Omega(q/\Lambda, e, x)x)][\Omega(q/\Lambda, e, x)/(q/\Lambda)]+ \rho+ [\theta(\theta + \rho)qx/(\Lambda\,\Omega(q/\Lambda, e, x))] - [1+ \varepsilon_x]g(1,e),$$

$$h(q/\Lambda, e, x) = r^* - \rho - [\theta(\theta + \rho)qx/(\Lambda\,\Omega(q/\Lambda, e, x))] + \varepsilon_x g(1,e).$$

The linearized dynamic system around the steady-state $((q/\Lambda)_{ss}, e_{ss}, x_{ss})$, where $e_{ss} = 1$ and $x_{ss} = 1$ is given by:

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[8] A complete characterization of the 3x3 system is done in Hoon, Hian Teck and Edmund Phelps, "A Structuralist Model of the Small Open Economy in the Short, Medium and Long Run," Discussion Paper No. 0102-25, March 2002, Department of Economics, Columbia University.

(12) $[(dq/dt)/q \quad (de/dt)/e \quad (dx/dt)/x]' = A[(q/\Lambda) - (q/\Lambda)_{ss} \quad e - 1 \quad x - x_{ss}]'$

where [...]' denotes a column vector, and the 3 by 3 matrix A contains the following elements:

$a_{11} = [(1+ \varepsilon_e)/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]\{f_{q/\Lambda} + [\varepsilon_e/(1+ \varepsilon_e)]\, h_{q/\Lambda}\}$,

$a_{12} = [(1+ \varepsilon_e)/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]\{f_e + [\varepsilon_e/(1+ \varepsilon_e)]\, h_e\}$,

$a_{13} = [(1+ \varepsilon_e)/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]\{f_x + [\varepsilon_e/(1+ \varepsilon_e)]\, h_x\}$,

$a_{21} = [(1- \varepsilon_{q/\Lambda})/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]h_{q/\Lambda} - [\varepsilon_{q/\Lambda}/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]f_{q/\Lambda}$,

$a_{22} = [(1- \varepsilon_{q/\Lambda})/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]h_e - [\varepsilon_{q/\Lambda}/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]f_e$,

$a_{23} = [(1- \varepsilon_{q/\Lambda})/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]h_x - [\varepsilon_{q/\Lambda}/(1- \varepsilon_{q/\Lambda}+ \varepsilon_e)]f_x$,

$a_{31} = 0$,

$a_{32} = g_e$,

$a_{33} = 0$.

We have $g_e < 0$ as a real exchange rate appreciation leads to a flow decrease of customers (so $dx/dt<0$ when $e>1$), and we can readily check that $f_{q/\Lambda} > 0$, $h_{q/\Lambda} < 0$, $f_x > 0$, and $h_x < 0$. In conjunction with the following two assumptions, we obtain signs for f_e and h_e, which provide sufficient conditions for a unique perfect foresight path:

Assumption 1: *Ceteris paribus*, an increase in e raises the rate of return to holding a share in the domestic firm by raising the quasi-rent, $[1- \varsigma]\, c^s$, taken as a ratio to q, by more than it decreases the rate at which the customer base shrinks, g_e.

Assumption 2: *Ceteris paribus*, an increase in e reduces the customer's *required* rate of interest through shrinking the (nonhuman) wealth to consumption ratio, $\theta(\theta + \rho)(qx/c^s)$, by more than it increases the required interest rate through raising the growth rate of consumption, $-\varepsilon_x g_e$.

Under Assumptions 1 and 2, we also have $f_e < 0$ and $h_e > 0$. We can then sign the elements in the matrix A as follows:

Lemma 1: $a_{11}>0$, $a_{12}<0$, $a_{13}>0$, $a_{21}<0$, $a_{22}>0$, $a_{23}<0$, $a_{31}=0$, $a_{32}<0$ and $a_{33}=0$.

B. *The 2 by 2 Dynamic System*

The two equations we examine are the linearized versions of (9) and (10), where we treat x as given. Then, it is straightforward to see that the slope of the stationary q locus is given by $de/dt\,|_{\dot{q}=0} = -a_{11}/a_{12} > 0$ and the slope of the stationary e locus is given by $de/dt\,|_{\dot{e}=0} = -a_{21}/a_{22} > 0$. Since both q and e are jumpy variables, the case where the stationary e locus is steeper than the stationary q locus in the (q,e) plane---with q on the horizontal axis and e on the vertical axis---gives rise to multiple rational expectations equilibria. We will focus on the case where we obtain unique rational expectations equilibrium, which requires that the determinant given by $a_{11}a_{22} - a_{12}a_{21}$ be positive. This implies that the stationary q locus must be steeper than the stationary e locus for unique rational expectations equilibrium. We depict this case in Figure 3, where we also draw a contour depicting the natural rate of employment, $1-u_n = \Theta(q/\Lambda, e)$ going through the intersection point.

A real exchange rate depreciation, in sheltering our economy from international competition, invites an increase in the markup, which translates into a decline of the real product wage and, given an upward sloping wage curve, leads to a decline in employment. Hence a real-exchange-rate depreciation can be seen to be a cause of the employment contraction. There is, however, also a sense in which a real-exchange-rate depreciation is also an effect, possibly alongside a decline of the stock market, of worsened prospects for jobs and output due an adverse exogenous shock. To illustrate this, let us consider the consequences of an unanticipated jump in the exogenously given external real rate of interest, r^*. In terms of Figure 3, we can readily check that the stationary q locus, which is the steeper locus, shifts to the left since at any given e, a lower q is now required to satisfy the asset pricing condition. On the other hand, the stationary e locus shifts to the right as a higher q is required to support a higher domestic real interest rate, which must now be equated to a higher external real interest rate. The result, as we see in Figure 4, is an unambiguous decline in the real exchange rate and the real share price, and the iso-$(1-u_n)$ contour passing through the new intersection point lies closer to the origin. Hence, the decline in the real exchange rate, and a depressed stock market as well, must correspond to worsened job prospects in our theory.[9]

II. Monetary policy

Is it conceivable, theoretically and empirically – as we will show below – that in an era of inflation targeting (implicit or explicit) where economic agents have come to form expectations of inflation that are largely borne out by experience, that the marked swings of the actual unemployment rate reflect primarily movements of the natural rate of unemployment? According to the Friedman-Phelps expectations-augmented Phillips curve, if the actual inflation rate equals the expected rate of inflation, the actual

[9] To get to the quasi-long run steady state where e is back to 1, we note that as customers are gained so x increases, both the stationary q locus and the stationary e locus gradually shift left to intersect at the original level of 1 with a lower q.

unemployment rate movement reflects swings in the natural rate of unemployment. We have spelled out a model of structural booms and slumps which can explain non-inflationary booms – such as the one seen in the United States in the late 1990s – and non-deflationary slumps – such as the one seen in Europe in the 1980s and, in some countries, the 1990s.

It is worthwhile to make a comment here about the sort of errors that a Central Bank – ignoring the lessons of our structuralist analysis here – is prone to make. Let us write the Taylor rule as follows:

$$i_t = \bar{i} + a(\pi_t - \bar{\pi}) - b(u_t - u_n), \tag{13}$$

where a and b are positive constants and i is the short-term nominal interest rate. Suppose that we observe an episode where an expectation of bright future prospects leads to a booming stock market together with a real exchange rate appreciation – such as the US economy experienced in the second half of the nineties. According to our theory, both the rise of q/Λ and e has the effect of lowering u_n. In the extreme case that helps make our point most starkly, suppose that the actual decline of u observed was entirely the result of the decline of u_n but the Central Bank attributes it entirely to a fall *relative* to u_n, that is, a fall of u- u_n. Then, although a correct application of the Taylor rule would suggest that the short-term nominal interest rate be left unchanged *on account* of employment or output stabilization, a Central Bank that does not see that the booming stock market and the stronger real exchange rate has lowered the natural rate of unemployment would incorrectly raise the short-term nominal interest rate to a level that is not justifiable.[10]

Woodford (2003) has shown that general-equilibrium models featuring the Taylor rule can usefully be solved to show that the equilibrium rate of inflation is a function of the current and expected future gaps between the natural rate of interest and the intercept term in the Taylor rule ($\bar{i}$ in (13)).[11] To prevent the inflation rate from either rising or falling, it would be necessary to adjust the intercept term in tandem with the natural rate of interest. It is, therefore, useful to know how the domestic real interest rate, r, which is our natural rate of interest, moves with the real share price (normalized by productivity) and the real exchange rate. By taking note that

$$c^s / \Lambda = \Omega(q / \Lambda, e, x),$$

we can, through various substitutions, obtain an expression for the "natural rate of interest":

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[10] The short-term nominal interest rate should nevertheless be raised in tandem with a rise of the natural rate of interest in accordance with an upward adjustment of the intercept term in the Taylor rule in (13).
[11] Michael Woodford, *Interest and Prices: Foundations of a Theory of Monetary Policy*, 2003, Princeton, Princeton University Press.

(14)

$$r = \frac{1}{[1-\varepsilon_{q/\Lambda}+\varepsilon_e]}\{\rho + \frac{\theta(\theta+\rho)(q/\Lambda)x}{\Omega(q/\Lambda,e,x)}\} + \frac{(\varepsilon_x - \varepsilon_{q/\Lambda})}{[1-\varepsilon_{q/\Lambda}+\varepsilon_e]}g(1,e) + \frac{\varepsilon_e}{[1-\varepsilon_{q/\Lambda}+\varepsilon_e]}r^*$$
$$-\frac{\varepsilon_{q/\Lambda}}{[1-\varepsilon_{q/\Lambda}+\varepsilon_e]}\{\frac{1-\mu^{-1}}{q/\Lambda}\}\Omega(q/\Lambda,e,x),$$

where, μ , the markup is a function of $q/\Lambda, e, x$. It is readily checked from (14) that a rise in *q*, holding other things constant, is associated with a higher natural rate of interest. Intuitively, a higher *q* raises the wealth to per capita consumption ratio and also increases the rate of growth of per capita consumption, consequently increasing the household's required real rate of interest. A real exchange rate appreciation, however, has an ambiguous effect on the natural rate of interest as it lowers the wealth to per capita consumption ratio but increases the rate of growth of a representative household's consumption. If the former effect dominates, which is a sufficient condition for saddle-path stability, then a real exchange rate appreciation in our model lowers the natural rate of interest. In steady state, of course, we have $r = r^*$.

In an era of structural slumps and booms when the natural rate of unemployment is shifting, a central bank that keeps the short-term real interest rate in tandem with the natural rate of interest will be able to control the equilibrium rate of inflation. Given a stable inflation rate, movements of the actual rate of unemployment will then reflect primarily movements in the natural rate of unemployment. Equivalently, the size of the gap between the short-term real interest rate and the natural rate of interest will be a measure of the deflationary pressure faced by the economy. (A positive gap implies deflationary pressure whereas a negative gap implies inflationary pressure.) A recent paper by two European Central Bank economists discuss the consequences of taking into account movements in the natural rate of interest in simple monetary policy rules.[12]

III. Evidence on Employment and the Real Exchange Rate

We have seen that the model outlined in Part I of this paper yields a positive relationship between the real exchange rate and employment, which goes against the Keynesian idea that real-exchange-rate depreciations improve competitiveness and cause employment to expand. In our customer-market model, real-exchange-rate appreciations induce domestic firms to moderate the consequent drain of customers to foreign suppliers by cutting their mark-up, which implies an increase of the demand wage in terms of domestic product. The upward shift in the demand-wage schedule pulls the economy rightwards and upwards along its "wage curve," causing employment as well as the product wage to increase. We now wish to test our proposition empirically.

The countries included in our statistical study are Australia, Austria, Belgium, Canada,

[12] See Nicola Giammarioli and Natacha Valla, May 2003,"The Natural Real Rate of Interest in the Euro Area," European Central Bank Working Paper Series.

Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, the U.K. and the U.S. We have data on both share prices and real (effective) exchange rates for these countries for the period 1977-2000. We now measure the exchange rate by the real effective exchange rate compiled by the IMF (relative price of consumer goods, *International Financial Statistics*). As before, an increase in the value of the exchange-rate variable implies a real-exchange-rate appreciation.

According to Keynesian theory an elevation of the real exchange rate raises the foreign price of our product and reduces the domestic price of imports, which makes the aggregate demand for domestic output fall, hence also employment. In contrast, structuralist theory gives the converse prediction: an elevation of the real exchange rate raises employment.

The estimated equation is of the error-correction variety,

$$(15)\quad \Delta f(u_{it}) = \beta_{j1}\left[\left(\alpha_i + \gamma_1 e_{i\,t-1} + \frac{\gamma_2}{s_{i\,t-1}} + \gamma_3\left(1+r_{t-1}^{*}\right)^5 + \gamma_4 p_{t-1}^{oil}\right) - f\left(u_{i\,t-1}\right)\right] + \beta_{ij2}\Delta\pi_{it} + \beta_{j3}\Delta e_{it}$$

where i is the country index and t denotes the years (i=1,2, …, 10; t=1976, 77, …. 2000). The equation postulates a long-run relationship between unemployment, on the one hand, and real exchange rates, real share prices s, world real interest rates r^* (measured in decimals) and real oil prices p^{oil}, on the other hand. [13] This represents an upward-sloping supply (convex) curve in the employment/real exchange rate and the employment/real share price planes. Inflation and exchange-rate shocks push unemployment off its long-run equilibrium path but – assuming that β_1 is positive, unemployment gradually converges back to its long-run equilibrium following such shocks.[14] The speed of adjustment towards equilibrium is measured by the coefficient β_1, which we hope will take a value somewhere between zero and one.

The function *f* is a non-linear function of the unemployment rate; $(u^{0.5}-1)/0.5$, following Bean (1994)[15]. The idea is to capture the (strict) convexity of the wage-setting relationship – each consecutive fall in unemployment requires ever larger shifts of labor demand.

Note that α_i is a country-specific fixed effect that captures any omitted country-specific effects. While each country has its own fixed effect, index i, groups of countries share a sensitivity coefficient β_1, as well as the sensitivity to inflation shocks (β_2) and changes in the real exchange rate (β_3).

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[13] We should note that the results are robust to the exclusion of the oil-price variable, which did not appear in the theoretical model above.

[14] Note that we allow for a short-term effect of real-exchange-rate changes on unemployment – to capture any short-run Keynesian effect – as well as a long-run relationship between the two variables.

[15] Charles R. Bean, "European Unemployment: A Retrospective," 38, April 1994.

Note that unemployment can be above its equilibrium path when price inflation is falling and above the path when price inflation is rising. The inflation term at the end of the equation is meant to capture this monetary effect.

The table below has the definition of the variables.

Table 1. Definition of variables.

u	Unemployment rate. Source: OECD.
e	Real effective (trade weighted) exchange rate, measuring the relative price of domestic and foreign consumer goods. Source: IMF.
s	Real share prices normalized by real GDP per employed worker. Source. IMF.
r^*	World real rate of interest (weighted average of G7 yield on government bonds). Source: IMF.
p^{oil}	Real price of oil. Source: Citibase.
π	Inflation (GDP deflator). Source: IMF.

The equation was estimated with a panel of 326 observations. The reported estimates were derived using *weighted least squares*. Table 2 has the coefficient estimates γ_1, γ_2, γ_3 and γ_4.

Table 2. Estimation results.

Coefficient	Estimate	t-statistic
γ_1	-0.02	4.12
γ_2	1.28	8.27
γ_3	2.76	9.09
γ_4	1.28	4.93

The results in the table are consistent with predictions of our structuralist model. First, an appreciation of the real exchange rate causes the steady-state unemployment rate to fall (t=4.12). Second, an elevation of real stock prices also lowers unemployment (t=8.27). An increase in the world real rate of interest raises unemployment (t=9.09). Finally, an increase in the real price of oil causes unemployment to rise (t=4.93).

The reader may wonder why we include real share prices and the world real rate of interest side by side since the former should encapsulate the latter. Our reason for doing this is simple: if share prices are sufficiently volatile due to irrational speculation, this may dwarf the contractionary effects of real interest rates. Table 3 has the group-specific coefficients.

Table 3. Further estimation results – group effects

Areas	Sensitivity coefficient		Inflation shock		Real exchange shock	
	Estimate	t-statistic	Estimate	t-statistic	Estimate	t-statistic
Australia	0.51	4.71	-7.81	2.88	-0.02	2.40
Europe*	0.15	7.93	-5.01	3.94	-0.01	1.95
Japan	0.08	3.85	-1.79	1.51	0.00	1.31
Scandinavia **	0.06	2.14	-8.02	3.05	-0.03	2.33
Canada	1.15	6.39	-6.00	2.41	-0.03	2.36
U.S	0.85	5.00	-2.41	0.81	-0.00	0.29

* Including Denmark ** Excluding Denmark

Table 3 shows that the Keynesian short-term effect of surprise inflation – measured by the first difference of the (price) inflation rate – causes unemployment to fall for all country groups. The employment effect of the inflation shock is smallest in Japan, then in the U.S. and roughly the same in the other four areas. The short-term unemployment effect of a real exchange rate appreciation is less robust. The sign of the estimated coefficient is also only correct in Japan.

The speed of adjustment to steady state is greatest in Australia, the U.S. and Canada and much smaller in Europe, Scandinavia and Japan. This confirms our prior expectations.

Importantly, the results from estimating equation (15) confirm a negative association between real exchange rates and the unemployment rate as suggested by structuralist theory.

We have so far omitted one important variable in our model of Section I. This is the market share of domestic producers, x_i. Clearly, domestic output and employment are an increasing function of the market share. The reason for this omission is simply lack of data. However, we did experiment with calculating the market share by assuming that it takes the value 1 in year 1978 – all domestic customers are customers of domestic firms – and then updating it using the following difference equation:

(16) $$x_t = x_{t-1} - 0.2\left(\frac{e_t}{\overline{e}} - 1\right)x_{t-1}$$

where $\overline{e}$ denotes the average real exchange rate over the period 1978-2000 – which is our proxy for the PPP real exchange rate and the number 0.2 is only a rough guesstimate of the responsiveness of the market share to real exchange rates. The equation suggests that an elevated (that is appreciated) real exchange rate makes customers drift away to foreign firms while a lower value of e makes new customers join domestic firms.

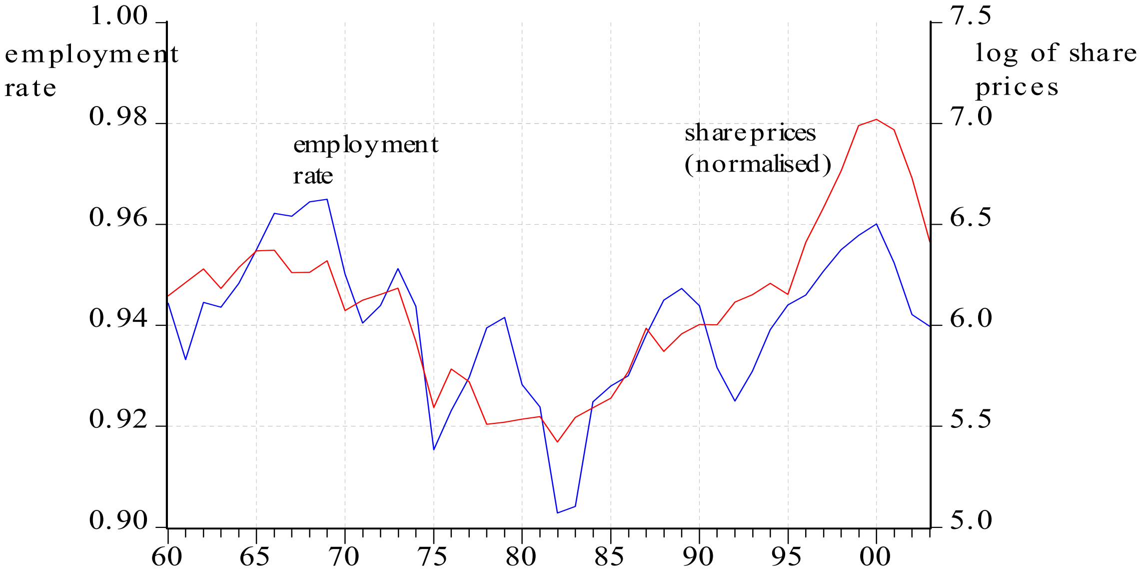
Including the market share x_i in equation (15) gave a negative coefficient with a t-ratio of 2.21. This suggests that a larger market share goes together with lower unemployment (hence higher employment rate and higher output). This is what we expected. Apart from this, the results were qualitatively unaffected.

We now turn to the most recent employment experience of the United States in light of our theory.

IV. The 1990s boom in the United States

We start by plotting the rate of employment in the United States (one minus the rate of unemployment) against the S&P500 index (in logs), when the share index has been normalized by labor productivity (all sectors) and the consumer price index. This is Figure 5 below

Figure 5. Share prices (normalized) and employment in the United States

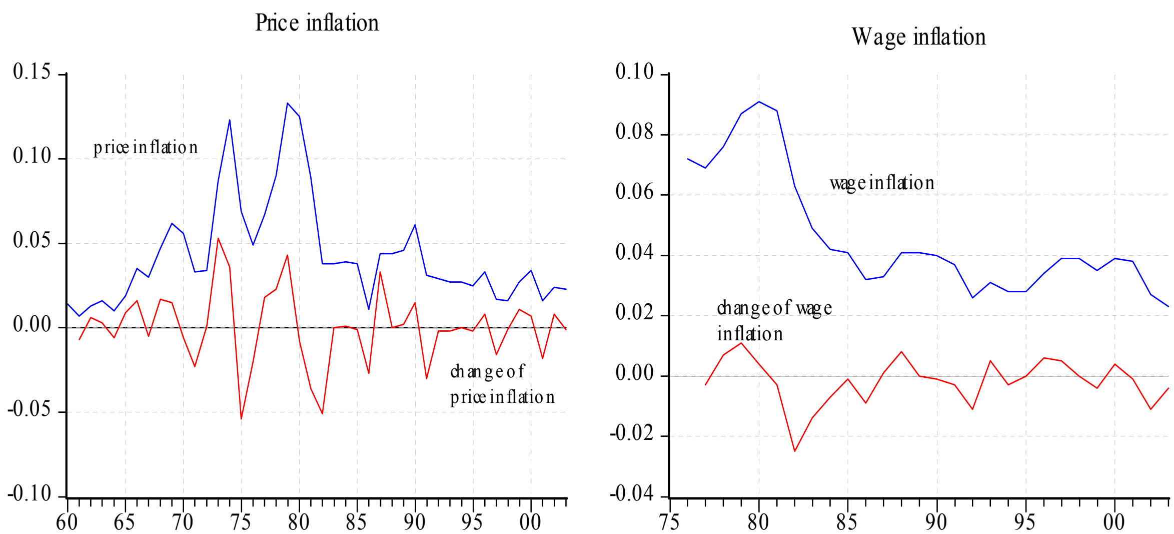


Employment rate defined as one minus the rate of unemployment (in decimals). Share prices are S&P500 normalized by the CPI index (1995=1) and a measure of labor productivity (1995=1). The value of the normalized share-price series in 1995 is 470, which is then also the value of the un-normalized series.

It comes as a pleasant surprise that the long swings in the two series are clearly related. We should note that a positive relationship between the two series has also been discovered for many other countries (see Phelps and Zoega (2001)). The persistent unemployment found in a number of Continental economies is simultaneously reflected in the failure of stock prices (normalized) to recover.

Going back to Figure 5, the fall in the employment rate in the US in the early 1970s corresponded to a fall in the normalized share price with a common trough in year 1975 and then again in year 1982. There followed a joint recovery peaking in year 2000, followed by a decline in both series. There are also instances when the two series go separate ways: Employment expanded in the late 1960s, the late 1970s and the late 1980s without a corresponding elevation of stock prices. It follows that these may possibly have brought in rising inflation since a rise in employment above its non-inflationary level – or natural rate – creates rising inflation in our model. The recession in 1990-1992 also seems to fit this mould although with the reverse sign – employment fell without a corresponding fall in stock prices. In contrast, the rise in share prices in the late 1990s appears not fully reflected in the employment rate. At its peak in year 2000, the employment rate had not yet reached the peak of the late 1960s, although the stock market was much higher. Similarly, the employment rate in 2003 is lower than what we would expect from the stock market, which is still high by historical standards. In light of our theory, this may suggest that employment could expand without risking inflation. (More on this later.) Figure 6 shows the inflation rate and its first difference over the same period.

Figure 6. Price and wage inflation in the US



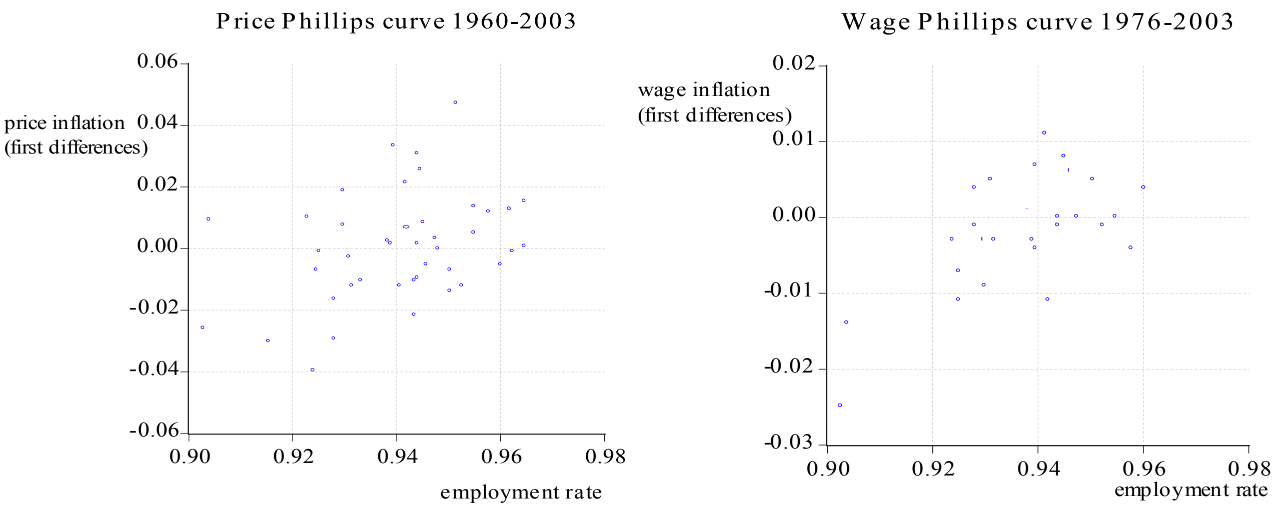
Inflation (in decimals) is measured as the rate of change of the CPI from last quarter of the previous year to the last quarter of the current year.

The periods of rising price inflation are the late 1960s, the late 1970s and – to a lesser extent – the late 1980s. These periods correspond to those when employment expanded without any accompanying elevation of share prices. In contrast, the inflation shock in the mid 1970s is clearly caused by the oil price hikes in 1973-1974. Wage inflation also picked up in the late 1970s and the late 1980s. Interestingly, wage inflation rose in the late 1990s to a greater extent than price inflation – the real wage rose during this period.

Phillips Curves

If share prices truly affect the level of the natural rate of unemployment they should be of use in explaining and predicting inflation. As a prelude, we plot in Figure 7 the relationship between the first difference of the inflation rate (CPI and wages) – that is unexpected inflation – and the employment rate. Not surprisingly, there emerges no clear relationship between the two variables. The data clearly reject the joint hypothesis of an expectations-augmented Phillips curve and a constant natural rate of unemployment.

Figure 7. The (non) relationship between inflation and employment in the US



The incorporation of share prices should help clarify the relationship between inflation and employment if changes in share prices go hand in hand with changes in the non-observable natural rate of unemployment. To test for this we now resort to regression analysis. The estimated equation has the following form

$$\pi_t = \alpha_0 + \alpha_1 \pi_{t-1} + \beta\left[\left(1-u_t\right) - \left(\gamma_1 s_t + \gamma_2 g_t + \gamma_3 e_t\right)\right] + \phi\Delta\left(1-u_t\right) + \varepsilon_t \qquad (17)$$

where π denotes inflation (either price inflation (CPI) or wage inflation), 1-u is the employment rate, s is the SP500 share price index normalized by labor productivity, g is the rate of (labor) productivity growth and e is the (trade-weighted) effective real exchange rate. We also include the first difference of the employment rate because a rapid expansion – or a rapid convergence to steady state – is more prone to generating rising inflation. The results follow in the table below.

Table 4. Estimation of Phillips curves

	Price inflation				Wage inflation			
	(1)		(2)		(3)		(4)	
Variables	Estimate	t-ratio	Estimate	t-ratio	Estimate	t-ratio	Estimate	t-ratio
Constant term	-0.77	4.07	-0.69	3.08	-0.51	6.23	-0.37	4.07
Employment rate	0.94	3.57	1.29	5.21	0.67	6.17	0.68	6.89
Change of empl.	0.91	3.88	0.81	2.88	0.61	6.09	0.45	4.12
Share prices (logs)	0.02	2.74	0.01	1.56	0.02	6.14	0.01	3.50
Productivity growth			0.86	1.87			0.28	1.18
Real exchange rates			0.00	0.14			0.03	1.53
Observations	42		42		27		27	
R-squared	0.34		0.61		0.67		0.73	
R-squared (adj.)	0.29		0.54		0.63		0.67	

Employment is measured in decimals. Share prices are normalized by prices (CPI, annual averages) and the level of labor productivity where its value in year 1975 is equal to the un-normalized one. Productivity growth is also measured in decimals and measures the rate of change of average (annual) productivity. Real exchange rates are measured by an index that takes the value 100 in year 1995.

In columns (1) and (2) we measure inflation with price (CPI) inflation while in columns (3) and (4) we use wage inflation (wages and salaries in private industry). The first column shows what happens if we use price inflation and only include stock prices, in addition to the employment rate, lagged inflation and the first difference of the employment rate. All three variables have a statistically significant coefficient with the expected sign. We then add (labor) productivity growth and the (effective) real exchange rate to the equation since these should affect the level of the natural rate of unemployment; both an acceleration of productivity growth as well as a real exchange rate appreciation should raise employment in our model. The statistical properties of the equation now improve. The productivity growth rate has a statistically significant and a positive coefficient while the real exchange rate has an insignificant coefficient. The positive and significant coefficient of the productivity rate implies that higher expected productivity growth lowers the natural rate of unemployment and hence also inflation in the equation above.[16] When adding the effective real exchange rate we are forced to

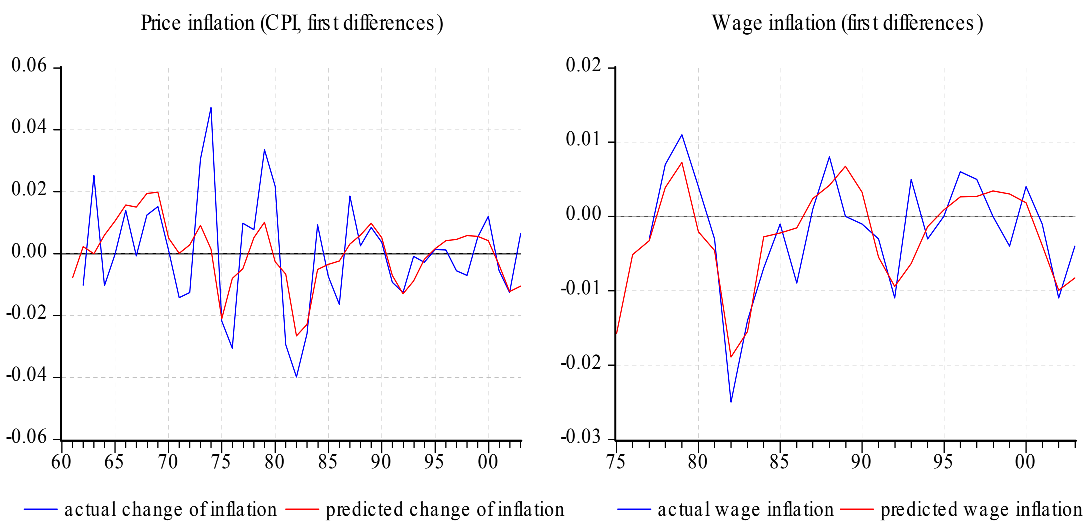
[16] This is in accordance with papers by, amongst others, Phelps and Hoon, "Growth, Wealth and the Natural Rate: Is Europe's Jobs Crisis a Growth Crisis?," *European Economic Review*, 41, April 1997; Christopher Pissarides *Equilibrium Unemployment Theory*, second edition, Cambridge, MA: MIT Press, 2000 (1990); and Laurence Ball "Productivity Growth and the Phillips Curve," manuscript, Russell Sage Foundation.

discard the first ten observations due to missing data. This gives a statistically insignificant coefficient.

In columns (3) and (4) we use the first difference of wage inflation (rate of change of wages and salaries in private business) as a dependent variable instead of changes in the consumer price index. Our wage data start in year 1975, which shortens the sample period by 15 years. However, we get even better results in this case. The R-squared of the equation is higher and the statistical significance of share prices and the real exchange rate is now much higher although productivity growth has a somewhat lower t-ratio. The coefficient for the real exchange rate is now clearly positive; real appreciation reduces inflation.

In Figure 8 below, we take the estimation results from the table above (columns (1) and (3)) to calculate the difference between the actual and the natural rate of employment – using only share prices – and then use this to predict the first difference of the inflation rate. The left-hand-side panel shows actual and predicted price inflation (first differences) while the right-hand-side panel shows wage inflation (first differences). In contrast to Figure 7, we now have a clear relationship between inflation and its causal variables.

Figure 8. Actual and predicted price and wage inflation



Predicted inflation uses the estimation results in columns (1) and (3) in Table 4.

The most notable prediction failures are the price inflation shocks in the mid1970s and the late 1970s that correspond to the two oil crises.

Cointegration

A perhaps more modern approach is to test for a cointergrating relationship between the employment rate and the normalized stock market variable. We start by testing for stationarity in the two series. In both cases we fail to reject the existence of a unit root (ADF statistic is –2.80 for the employment rate and –2.48 for normalized share prices where the 5% critical value is –3.52). A likelihood-ratio test for cointegration indicates the existence of one cointegrating equation (CE) at 5% significance level as shown in Table 5 below.

Table 5. Test for a cointegrating relationship between employment and share prices

Eigenvalue	Likelihood Ratio	5 % Critical Value	1 % Critical Value	Hypothesised Number of CE(s)
0.40	27.70	25.32	30.45	None *
0.14	6.21	12.25	16.26	At most 1

* Denotes rejection of the hypothesis at 5% significance level

We conclude that the stock market can account for the persistence observed in the employment-rate series. However, we should point out that a better model of employment persistence is the one that takes into account infrequent shifts in mean unemployment.[17] This is obvious from viewing unemployment plots for the European economies but also from looking at longer time series for the United States. In a way, the apparent unit root found in the 42 annual observations 1962-2003 is caused by the short sample span. Doing similar tests using US data for a hundred years gives a clear rejection of the existence of unit roots.[18] This is the main reason why we do not adopt this more modern approach of cointegration analysis in the main sections above.

The 1990s

The current sluggish performance of the US economy follows one of the more remarkable booms in modern history. The late 1990s was a period of simultaneous output and productivity growth, low unemployment and stable inflation, culminating in an unemployment rate of only 3.9% in the fourth quarter of the year 2000. In 1996-2000 the rate of growth of output per man-hour in the business sector ranged between 2.3% and 3%. The absence of rising inflation during this period came as a surprise since the level of the natural rate of unemployment was commonly estimated to be in the range of 5-6% by the mid 1990s. So the question remains if our model can account for this non-inflationary boom.

[17] See Bianchi and Zoega, "Unemployment Persistence: Does the Size of the Shock Matter?," *Journal of Applied Econometrics*, 13, May/June 1998; Papell, Murray and Ghiblawi, "The Structure of Unemployment," *The Review of Economics and Statistics*, 82, May 2000.
[18] Bianchi and Zoega, "Challenges facing natural rate theory," *European Economic Review*, 41, April 1997; and Smith and Zoega, "Global shocks and hysteresis affecting unemployment," manuscript, Birkbeck College, December 2003.

We now invert equation (17) so that it explains the employment rate, and move inflation to the right-hand-side.

(18) $1-u_t = \alpha_0 + \alpha_1\left(1-u_{t-1}\right) + \beta\Delta\pi_t + \gamma s_t + \varepsilon_t$

The results follow in the table below.

Table 6. Estimation of employment equation

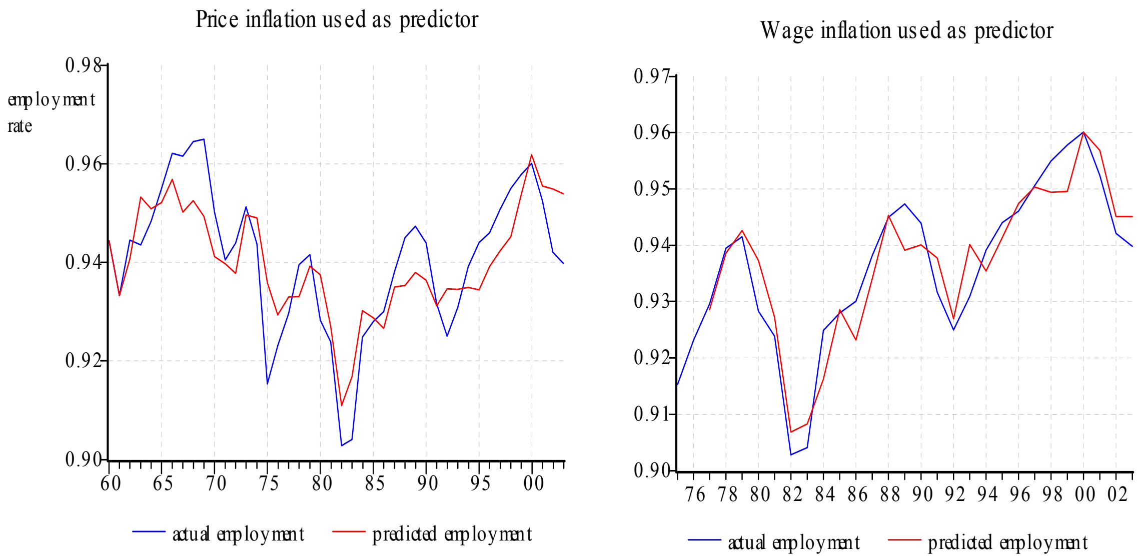
	Price inflation (on right-hand side)		Wage inflation (on right-hand side)	
Variables	Estimate	t-ratio	Estimate	t-ratio
Constant term	0.41	4.37	0.57	3.90
Lagged empl. rate	0.50	4.06	0.31	1.75
Inflation shock	0.25	2.49	0.87	6.07
Share prices (logs)	0.01	2.23	0.01	2.80
Observations	42		27	
R-squared	0.75		0.87	
R-squared (adj.)	0.73		0.86	

See explanations below Table 4.

Not surprisingly in light of equation (17), we find that rising inflation causes employment to go up and that higher share prices and higher employment go together.

We can now use this estimated equation to simulate the employment path for the United States. Figure 9 plots actual and simulated – that is predicted (within sample) from Table 6 – employment path for 1960 to 2003 using price inflation, and then for the period 1976-2003 using wage inflation.

Figure 9. Simulated and actual employment rates



First the left-hand-side panel that used price inflation: The main discrepancies appear in the late 1960s – the boom was too strong! – the recessions of 1975 and 1982 – too steep – the late 1980s, which experienced a stronger expansion than predicted, and the last few years when employment has been lower than what we would have expected. While the price equation captures the 1990s boom well it does not fully account for the fall in employment since year 2000. In contrast, the wage equation captures very well both the late 1990s boom as well as the end of it. This goes to show that the wage deceleration in recent years has coincided with rising unemployment, which again suggests that the rising unemployment may in part be due to cyclical – as opposed to structural – factors.

We conclude that our structural model can account for the long swings in the rate of employment in the United States. In particular, it sheds a new light on the non-inflationary boom in the late 1990s. This was one of the more remarkable booms in modern history with simultaneous output and productivity growth, low unemployment and stable inflation. The absence of rising inflation during this period came as a surprise to many since the level of the natural rate of unemployment was commonly estimated to be in the range of 5-6% by the mid 1990s. However, we have shown that the natural rate of unemployment may have been pushed down during this period due to expectations of future productivity improvements, expectations captured by the booming stock market.

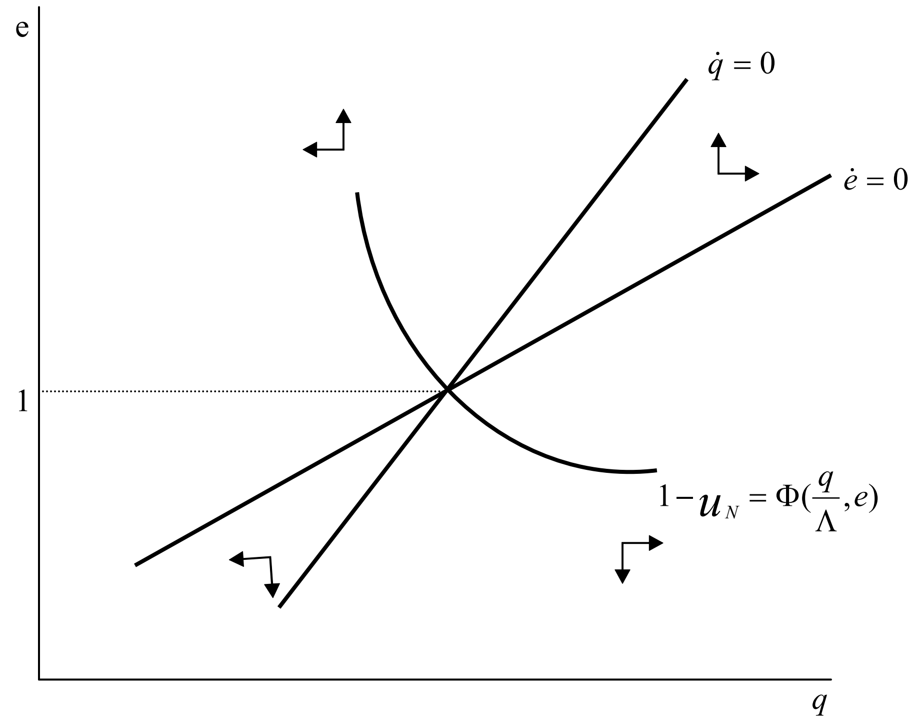


Figure 3. Unique Rational Expectations Equilibrium

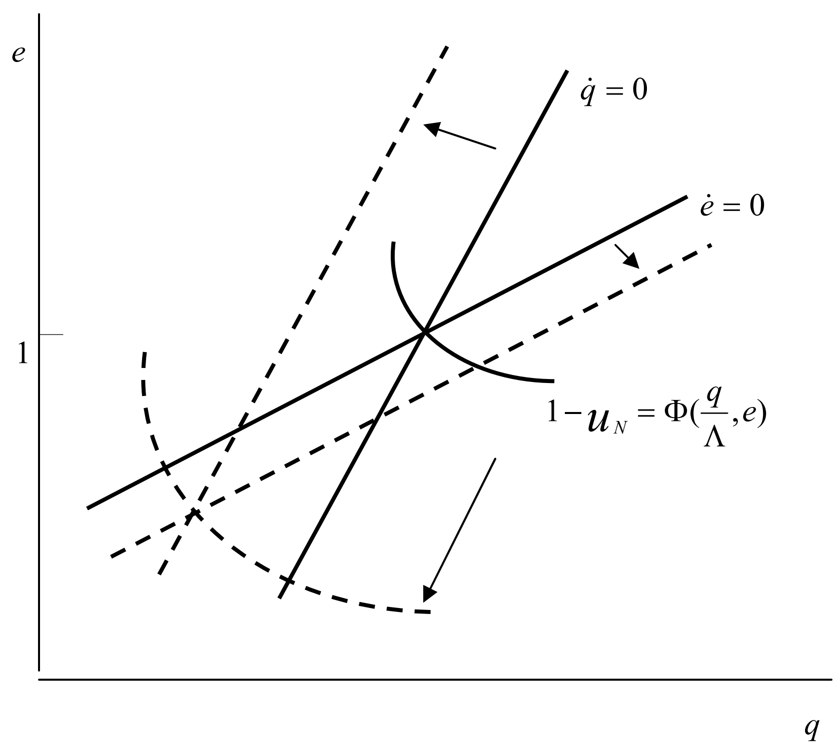


Figure 4. Effect of Higher r^*