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Changing Prospects:
A Structuralist Link through the Capital Market to the Course of Business Activity

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In a string of papers beginning in the 1980s and a book in 1994 I have been exploring the *structural sources* of lengthy changes, whether swings or permanent shifts, in the course of business activity – and the course of productivity too (although productivity growth will not be my focus here). This has meant theoretical analyses and empirical studies of how non-monetary forces disturb the path of employment, unemployment, hours, and so forth through non-monetary channels, or mechanisms – in contrast to Keynes, for example, who sought to understand the employment effects transmitted through monetary channels. In the first stage of this research the focus was on the short-run and longer-run effects of actual and identified changes in preferences or technologies, which impact on the world real rate of interest, the world price of oil, the rate of technical progess, etc. In the last stage, which I am still caught up in, the focus has been on the long-run effects of various economic institutions, which tend to impact on the responsiveness of businesses, the flexibility of markets etc.

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It would be a theoretical error to say that such actual shocks in no case generate a "swing." In the structuralist models, some of those shocks are able to generate a big "down" followed by a recovery. Clearly, a fiscal shock might be neutral in the long run but be contractionary in the short run, so that employment would at first decline and then tend gradually to return to its original path. (I am inclined to infer from the data that such a swing actually happened to several economies in continental western Europe.) A reverse shock of this kind would cause employment to rise at first, then sink back.

In between these two stages, however, are several papers that take up a wholly different category of influences on economic activity (and growth too), namely, *future prospects*. Accordingly, at any moment there can occur a "prospective" shock, meaning, a *new* future prospect or a (new) *change* in some already anticipated prospect. (I leave the terminology somewhat fluid.) This is different from Keynes's "animal spirits" in that it these prospects refer to *events* in the future that would impact on the willingness of existing firms and start-up entrepreneurs to invest and the willingness of investment bankers and the stock market to finance them. Keynes was content simply to treat the "spirits" of the investing firm as exogenous, thus effectively introducing an autonomous component into investment demand – possibly because there are so many future prospects that may be influential in determining the "spirits."

In the first part of this lecture I am going to survey or in one case introduce various kinds of events whose prospects of occurring in the future impact on economic activity and show how, theoretically, each prospect transmits through the capital market channel an effect on the course of economic activity, starting from the present moment; and in each case I will point to some evidence of an impact on economic activity. In the second part I am going to try to get a sense of the quantitative importance of future prospects in general – call it speculation about the future – *relative* to the importance of unexpected developments actually observed.

FUTURE 'DEBT BOMBS,' PRODUCTIVITY SURGES AND WARS

In the category of future prospects perhaps the oldest topic is the effects in the present of some newly formed expectation of a future "debt bomb," as I have dubbed it – for example, the enactment of a tax cut with delayed effect and a sunset provision (so there is some small interval over which there is a big government deficit). Another topic in this category is the sudden expectation of a future step-increase in productivity at some specified date. A third topic, which I want to introduce here, is the expectation of the start of a war and of the end of a war. Maybe a terrorist attack would be a more modern way to interpret it. In all these cases I want to discuss in a highly informal way some historical evidence relating to each of these cases. I will take these up in the above order.

As I may have revealed already, I will not suppose that there are differences of opinion about the magnitude or the time of the prospective events; and where it is interesting to introduce a probability, it is a subjective probability held by all. The aim is simplicity, not realism, of course – although the media tend to propagate a conventional view to the point where it comes to be nearly universal.

Future 'debt bombs' and pension overhang

The literature on the present expectation of a future fiscal shock goes back quite far. A Keynesian treatment of the subject is offered by Olivier Blanchard in 1981. (I may have had an influence in that paper as we discussed future shocks in 1978, although my analysis was not regarded as satisfactory and I did not pursue it.) However, the proposition that the enactment of an explosion of transfer payments or tax cuts in the neighborhood of some future date $t1$ will be a depressant for real asset prices at that time and that the public's grasp of that prospect will have repercussions for the level of real asset prices in the present is much more general. A few years ago Hian Teck Hoon and I set out a closed-economy model showing that the sudden expectation of such a tax cut, if expected by managers of firms, will immediately cause a drop in the shadow price they attach to a unit of the business asset.[2]

It is easy to establish this proposition in terms of the sort of turnover/training model that Hoon and I have frequently used, provided we appeal to the non-Ricardian property that government debt is net wealth. Then the increase in the public debt around $t1$ causes the long-term real interest rate to be elevated at that time, with the result that the shadow price at that time must be lower than it otherwise would have been, evaluated at the original level of the stock of the business asset, which is simply the stock of trained

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[2] Hian Teck Hoon and Edmund Phelps, "Tax Cuts, Employment and Asset Prices: A Real Intertemporal Model," Columbia Economics Working Paper, October 2001, revised July 2002.

employees. By an inductive argument it follows that the shadow price at the present moment $t0$ is also lower than it was; in fact, we don't need such an argument, since the integral giving the present shadow price involves interest rates after $t1$, which are increased, so the value of the integral is reduced. A beautiful observation noticed by Hian Teck is that the short term real interest rate may actual fall, since consumption will jump up and thereupon be steadily falling, thus causing the real rate of interest required by savers to be gradually falling down to their elevated future level.

Unfortunately this model, which I want to stick to here, will not deliver such results in the case of a small open economy, for in that case real interest rates are given by the world capital market, which the economy is not large enough to affect. To obtain the proposition we want for a small open economy Hoon and I turn to a customer-market model.[3] Then there is an elevation of domestic real interest rates in the future, as a result of the crowding in of more public debt, which crowds out overseas or domestic customers. (Hian Teck has been able to prove that there is immediately a real exchange rate depreciation with the expectation of the future tax cut, which is followed by a gradual exchange rate recovery. But I will not say more about this analysis here.)

Some evidence. There is positive, though indirect, evidence of the significance that such fiscal prospects have for the level of economic activity. In the past several years investors in a number of countries have come to be appreciate that their country faces a very large overhang of pension liabilities in relation to present projections of GDP, owing either to governments having overestimated the growth of tax revenue over the future when they were setting benefit levels or to having disregarded the coming bulge of baby boomers who will soon be entering into their retirement years. Allison Schrager, a PhD student at Columbia, has taken this opportunity to regress the average price-earnings ratio (and also the average price-dividend ratio) on the projected pension benefits to GDP ratio for a cross-section of OECD economies, using data prepared for the European Commission. The results show a statistically significant coefficient of the right (negative) sign on the pension variable. If this is in fact the case, it means that the prospect of tax increases and mounting paper wealth from pension entitlements do indeed impact on the capital market, just as the theory implies. There is plenty of other evidence supporting the belief that a decrease of share prices has contractionary consequences for the level of economic activity as measured by the unemployment rate and participation rates.

So far, then, the theory is doing well enough.

Future productivity surges

To analyze the sudden expectation of a future step-increase, or lift, to productivity we can use the turnover-training model, which is generally very convenient – when it can do the job. A simple analysis is provided in a paper I wrote with Fitoussi, Jestaz and Zoega.[4] The basic proposition is nicely illustrated by the phase diagram in Figure 1. Here I have simplified the model further by abandoning rising marginal hiring costs and replacing that with constant hiring costs. Then the locus of points at which the stock of employees is

[3] Hian Teck Hoon and Edmund Phelps, manuscript for this conference.

constant at a firm is horizontal. (If employment is increased, the quit rate is increased as a result, with the consequence that there must be an equal increase in the hire rate; but since the derivative of the hire rate with respect to the shadow price of the employee is infinite in the constant-costs case, no increase in the shadow price is required to maintain a steady state at the increased employment level.) The phase diagram shows that the shadow price jumps up, causing employment to grow until $t1$, at which point the path of the system must have just reached the new saddle path; from that point, the system follows the saddle path, proceeding toward the new rest point. (I omit details concerning wealth.) The dynamic system is set out in the Appendix for readers interested in seeing the equations underlying the phase diagram.

To gain the essential insight we need only consider the integral expression giving the value of the shadow price at the present time, $t0$. The step-increase in the prospective future rents on the business asset – the employees – unambiguously increases the value of the integral, evaluated at the initial employment path. And, again, any such increase in the shadow price of the employee, unaccompanied by any increase in the opportunity cost of training additional employees, unambiguously stimulates a sharp increase in hiring, which pulls up employment; it is implied to continue to rise until the expected moment when the productivity surge is expected to occur.

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[4] See Phelps and Zoega, ‘Structural booms: productivity expectations and asset valuations,’ *Economic Policy*, 32, April 2001. See also J.-P. Fitoussi, D. Jestaz, E. Phelps and G. Zoega, “Roots of the Recent Recovery,” *Brookings Papers on Economic Activity*, 2000, Spring issue.

As so often happens, the ink had hardly dried on the manuscript for the April 2000 Brookings meeting where this paper was presented when another paper emerged, this one by Beaudry and Portier, conveying the same basic idea in a more neoclassical sort of model; then still another paper appeared, also independently, by a Columbia PhD student, Steffen Reichold.[5]

Some evidence. How can we adduce evidence that the investment boom of the late 1990s in the US economy and several others did rest, at least to an important degree, on newfound expectations of a lift to productivity on the horizon? And, similarly, how can we test the thought that the great investment boom of the 1920s was likewise driven by expectations of rapid productivity growth over the future? Perhaps we can never obtain strong enough evidence to satisfy all skeptics. However, for me at any rate, it is important circumstantial evidence supporting that interpretation of the 1990s boom that productivity growth has in fact been startlingly rapid in the four years beginning in 2000 and appears to be slowing down only very gradually. With productivity growth so rapid in those years, it is easy for me to believe that many managers in industry had information in the second half of the 1990s leading them to expect a very substantial lift to productivity and hence to investment returns in the next several years. Now consider the 1920s boom. The parallels of that boom with the 1990s boom have led several of us to dig out the Kendrick data on

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[5] Paul Beaudry and Franck Portier, "Stock Prices, News and Economic Fluctuations" (title to be verified; Steffen Reichold, "'New Economy' and 'Productivity Slowdown': Can Learning about Rare Regime Shifts Explain Aggregate Stock Market Behavior?" PhD thesis, May 2002.

productivity growth in that bygone era. I was stunned to see in the Commerce Department volume *Long Term Economic Growth 1860-1965* that productivity lifted off onto a much higher path during the 1930s.[6] Alex Field's paper a few months calculated total factor productivity growth rates to show just how remarkable technical progress was between 1929 and 1941.

I alluded to the productivity gains in the 1930s and, to date, in the 2000s in a couple of pieces in the financial press where I agued that Alan Greenspan was mistaken to think that the recent spate of productivity gains translates into high employment: if the productivity gains were already anticipated in the mid- and late 1990s and were precisely the inspiration for the wave of new investments at that time, then the realization of these gains will not occasion another wave of investment; the realized gains are "how booms end, not how they begin." [7] Employment in this decade too is still pretty slumpy, though now recovering at a rate so rapid that – if it holds up – the unemployment rate ought to reach the neighborhood of 5 per cent by the end of the year. The question is only whether other forces may stall that march back to normalcy, as happened in the late 1930s when the clouds of war stopped in its tracks the recovery from the depression.

War prospects.

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[6] Edmund Phelps, Interview, *Il Sole/24 Ore*, Rome, July 2003. See also the short article by Alexander J. Field, "The Most Technologically Progressive Decade of the Century," *American Economic Review*, 93, September 2003, 1399-1413.

[7] Phelps, "False Hopes for the Economy – and False Fears," *Wall Street Journal*, June 3, 2003 and Phelps, ""Crash, Bang, Wallop," *Wall Street Journal*, January 5, 2004. These and two other commentaries are assembled in my paper, "The Boom and the Slump: A Causal Account of the 1990s/2000s and the 1920s/1930s," *Journal of Policy Reform*, 7, March 2004, 3-19.

The essence of my thesis is as follows. At the present time, the value, to be denoted $q(0)$, that a firm's manager would put on having an additional functioning employee is a probability mixture of the value of that employee in the scenario in which war breaks out, weighted by the subjective probability of war, π, and the value in the scenario in which war does not break out, weighted by the probability the war does not break out, $1 - \pi$. The war scenario gives a lower value, since the manager anticipates that there will be an increased tax burden on the firm's profits or sales or both in the event of the war. The conclusion that can be deduced is that any *small increase* in the subjective probability of war *lowers* the value of the probability mixture – the so called "expected value" of the two integrals (the one the no-war integral, the other the war integral). The argument for that conclusion involves the point that the firm's reactions in the event of war do not have to be factored into the result, since small adjustments by the firm in its hiring rate will not have a first-order effect on the value of the integral, the hiring rates having been in the neighborhood of their q-maximizing levels to begin with.

Another proposition that is obvious at least to economists is that, with the passage of time, the date at which the war is feared to break out draws *nearer* – unless $t1$ is pushed back one day (or more!) for every day that goes by after $t0$. So the present discounted value of having an extra employee, which means discounting back to the current time t, not to the initial time, $t0$, is *falling*, since the *losses from the war* in the event it occurs are getting nearer, hence *discounted less heavily*.

In the event the war breaks out, the passage of time is the firm's friend: The date at which the war is hoped to *end* draws nearer – unless that date, *t*2, say, is pushed back one day or more for every day that the war goes on after *t*1. Here the *gains* from the war's end are being discounted less heavily as the end of the war nears.

Some evidence. If I am not mistaken, then, this analysis leads to the proposition that the prospect of war ahead causes a drop in the shadow prices put on business assets. In almost any theory, there will be, in reflection of that drop, a sympathetic drop in share prices too. And if, during a war, the prospective time left to go before the war's end keeps shrinking as expected or even faster than expected, these shadow prices – and share prices too – will tend to be recovering. Is this what happens, at least in normal cases? Certainly the evidence in the years leading up to World War II bear out this story. Painting with a broad brush, I would say, going largely by my recollection of the data, that share prices fell and fixed investment expenditures as a share of GDP fell in the United States from 1937 to 1941. The same was true, as I recall, in the Netherlands over the late 1930s. Then, during the war years 1942 to 1945, the stock market in the United States was strongly rising – in a recovery mode.

I would just add that, as you may know, the real prices of shares did not recover fully to their lofty levels of 1936 and 1937 for quite some time – not until the last years of the 1960s, if I remember correctly. I would say by way of explanation – entirely in the spirit of my thesis that future prospects are important – that the cloud of the cold war came over the US economy by 1948, blocking any chance of a full recovery. With the Korean War of the early 1950s this tension broke out into open conflict.

Drawing conclusions .

If these future prospects and possibly others not treated here are empirically important, then we can conclude that real-life economies with an active commercial character are almost *never* vibrating up and down along their saddle paths. They are *almost always* off the saddle path. Somewhat surprisingly, the trajectory of shadow value of the employee in the above model jumps off the saddle path in spite of the simplifying postulate there of constant (rather than increasing) marginal hiring costs.

The pressing question now is whether the changes in future prospects are pronounced enough from one year to the next or from one decade or era to the next to generate a generally important – and typically fluctuating – discrepancy from the saddle path. I would like in the second part of this lecture to tackle that question.

JUST HOW MUTABLE IS THE OVERALL FUTURE PROSPECT?

A long-time theme of mine regarding fluctuations is that most of the national economies of the past few centuries are *vicissitudinous* – better, *mutable* – especially the more capitalist economies and those highly interdependent with the capitalist world.[8] I mean that a capitalist economy is always changing qualitatively and often lastingly. So the description of a theoretical economy given by a stochastic steady-state model does not really fit this

[8] In *Webster's*: **vicissitude** *noun* **1** the quality of being changeable **2** the natural change or mutation in human affairs (from the Latin *vicis*, change, alternation). **vicissitudinous** adj. marked

sort of economy. Maybe some macro statistics will pass some tests for stationarity but, if so, that may indicate only that it takes a few decades for an economy to transform itself; it doesn't mean that we can use a model estimated on 19^{th} century data to obtain the best possible prediction of, say, the rate of technical progress or the long-term natural unemployment rate. Although some of these "parameters" appear to be trendless, they also appear to be capable of shifting perceptibly from one half-century to another. Some theorists speak of regime change or model change, but why not admit that the regime is always evolving, sometimes abruptly, and the model with it? I have to add that I am not exactly sure what it means to speak of the best possible, or true, prediction or the expected value of these things: using what model?

As Part I showed, the shadow value of the business asset is capable of jumping off the saddle path; in fact, the shadow value may never be on the saddle path for a single day of its life except to pass through to the other side on some occasions. (This is true even though I posited constant costs of hiring.) But how much do these shadow prices move in fact? And do their movements, such as they are, match up with shifts (surges) and swings in investment activities of the various kinds – hiring, customer chasing (advertising, cutting markups), plant and office construction, etc.?

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by or filled with vicissitudes. **mutable** adj. **1** prone to change **2** capable of or liable to mutation (from the Latin *mutare* to change).

Inferential movements in the shadow values

Hian Teck Hoon chanced to read a paper by Casey Mulligan that looks into the part played by public finance distortion in the movements of labor supply of American workers over the period 1889-1996.[9] For his neoclassical model Mulligan adopts the neoclassical model of labor-leisure choice, with its condition $\mathrm{MRS}(C, \overline{L} - L) = v^h$, where the MRS function gives the marginal rate of substitution (*MRS*) between consumption and work, or "marginal value of time" in terms of the final good, and is increasing in current consumption C and in hours worked L, hence decreasing in leisure; the right-hand side variable, v^h, is the after-tax hourly wage rate. The latter is related to the firms' demand wage v^f and to the proportional tax rate τ on after-tax wage income by $v^h \equiv (1+t)^{-1} v^f$. Invoking pure competition, he equates v^f to the marginal product of labor, MPL. The result is $\mathrm{MRS}(C, \overline{L} - L) = (1+t)^{-1} MPL$. The implication is that an increase of τ, in decreasing the right-hand side, operates to decrease hours, given consumption and the value of MPL. Mulligan argues from his empirical exercise that marginal tax rates are well correlated with labor-leisure distortions at low frequencies, but they cannot explain the distortions during the Great Depression, the Second World War and the 1980s: the decade-to-decade fluctuations in consumption, wages, and labor supply do not jibe very well with this competitive equilibrium model.

From the perspective of my structuralist models, the difficulty with this competitive-equilibrium theory – adopted wholesale by the real-business-cycle school in

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[9] Casey Mulligan, "A Century of Labor-Leisure Distortions," National Bureau of Economic Research, Working Paper 8774, 2002.

the 1980s – is that it lacks business assets and the possibility of corresponding fluctuations in the shadow values attaching to those assets; as a result, the model is hopelessly myopic. Hian Teck, viewing the matter accordingly, reasoned that to understand the depth of the downturn in the 1930s it might be of crucial help to introduce such shadow prices. From customer market theory, Hian Teck derived a contrasting employment equation: In the Phelps-Winter model, a firm generally profits from the sluggishness of information, for it can "mark up" its price above marginal cost without at once losing all its customers; this transient monopoly power gives value to its current stock of customers. Let m denote the markup $(P - MC)/P$, where P is price and MC is marginal cost. Then it is straightforward to deduce that $1 + m \equiv y$, where the function y makes m inversely related to $\tilde{q}$, the shadow price that firms attach to a customer when taken as a *ratio* to how much output a customer has to be supplied. (That ratio is fully analogous to Tobin's Q ratio.) In this model, the analogue to Mulligan's labor-equilibrium relationship is $\mathrm{MRS}(C, \overline{L} - L) = (1 + t)^{-1}[y(\tilde{q})]^{-1} MPL$. If we substitute for MPL the parameter Λ and, in the closed economy case, substitute ΛL for C in MRS, then L is fully determined. An increase of $\tilde{q}$ pulls up the right-hand side (i.e., it increases the v^h that firms are willing to offer); and, since $\mathrm{MRS}(\Lambda L, \overline{L} - L)$ is doubly increasing in L, that induces an increase in hours supplied. Thus the *markup* wedge between net pay and labor's marginal value productivity joins the *tax* wedge as a potential factor in the determination of the equilibrium (i.e., correct-expectations) path of employment, here average hours. Sometimes both are needed in an analysis because they move in opposite directions, so the one helps to escape from the other.

My point here, after that lengthy exposition, is that we can *infer* what the 1930s shadow price of customers must have dropped to from the 1920s by solving for the $\tilde{q}$ ratio that solves the equation, given the data and given our "knowledge" of the functions appearing in the equations. We can do that for each decade of the past century, thus obtaining a century of inferred $\tilde{q}$ ratios attaching to the business asset we call the customer.

To do the same with the turnover-training model we can use the equation giving the incentive wage as a function of the unemployment rate and the shadow price of the functioning employee to solve for the shadow price that delivers the correct wage rate, taking account of tax rates. Thus we could calculate decadal levels of the shadow value of the employee.

Since these shadow values of the various business assets have a lot of work to do to reconcile the equation with the observed employment levels in the 1930s, the World War II years (1941-45) and the 1980s, one can presume that the required shadow values will exhibit quite a lot of fluctuation from decade to decade. This is one piece of circumstantial evidence for believing that future prospects are important: Over the past century, the world real interest rate, trend growth rates of national productivity and tax rates have not show enough variation to be able by themselves to push the shadow values enough to explain the huge swings of the 1930s, the war years and the

1980s. I admit, though, that I have not carried out that project; I am just surmising from impressions gleaned from the data.

What do share price time series say?

To obtain another somewhat indirect view of the movements of the shadow prices of business assets we might do well to examine the time-series of stock-price indexes, such as the Standard and Poor 500 index (and its predecessors).

We would like to find evidence that would help to establish (or to disestablish, as you like) the proposition that share prices are driven by subject understandings of future prospects to an important degree, not just by unexpected developments in the situation and performance of the economy. How to do that? To do that we need to distinguish the actual change of the share price level from the change that was previously expected; then we have to decompose this into the component attributable to surprises in observable things and the component presumably reflecting unanticipated revisions, based possibly on reappraisals of existing information or surprising new information, of the economy's future prospects. The dichotomy is between the unexpected changes in observed levels of present variables and the unexpected changes in the forecast future.

To this end, let Rx denote the logarithmic rate of change of the variable x; and let F(x) denote the expected, or forecast, value of x. In this notation, the familiar Fisher equation applied to the expected proportionate rate of change of the share price is

$$F(R(p)) = [F(r) - d/p],$$

where *p* denotes the share-price level, R gives its rate of change, and F gives the expectation about that rate of change; *r* is the short-term real rate of interest; and the last term is the dividend-per-share as a ratio to price per share (hereafter, the dividend-price ratio). Then subtracting the *actual* R(*p*) from both sides and multiply both sides by minus one we get

$$R (p) - F(R(p)) = d/p + R(e) - F (r) + [R(p) - R(e)],$$

where *e* denotes earnings per share. The first three terms represent the observable part: share prices may have gone up more than expected (or fallen less) because earnings growth was good or the dividend payout ratio was good in relation to the expected real interest rate, as embodied in Treasury inflation-protected bonds, say. The component in the square brackets, however, is the rise of share prices relative to earnings, and presumably is driven by changes in future prospects (although possibly some present factors get in there in the real world).

The attached Figure 2 plots the first component (*sans* the real rate of interest, which could not be organized in the remaining time) and plots in the same chart the second component for the period from 1871 to the recent time. It is clear that *both* components show a great deal of movement. It will be interesting to see whether the latter component is a *better* predictor of good times *ahead* than the first component. In theory, it seems to me, the latter component (the speculative one) is the better predictor of the future, since the latter component is *all about* the future. But deciding this question will require a careful analysis. The answer is not apparent at a glance.

CONCLUDING

I have been arguing that macroeconomics must incorporate future prospects if it is to capture the big swings in economic activity in anything approaching their entirety. Not only that: without doing so our models will not be able to speak to many policy issues of the day. For example, the supply siders say, cut tax rates – and after that, cut them again, then again; the budgetary deficit is, for them, not important, it seems. Then Robert Rubin and Lawrence Summers hinted at a counter-theory which says that budgetary deficits also have a contractionary effect operating through the capital market – through the Wall Street channel. Hian Teck and I have managed to put the argument on a theoretical footing: A current and prospective pay-down of the public debt would operate to elevate asset prices – an effect that exists whether or not the long rate of interest is simultaneously lowered; and that effect could – again, theoretically – elevate the normalized shadow price of customers, $\tilde{q}$, by *enough* to pull up v^h and L by *more* than the contractionary effect from the *supply-sider* channel pushes them down. In this framework, one cannot expect to understand well the medium-term responses of employment (here hours) to fiscal shocks without considering the asset price responses to such shocks, in particular, to current as well as prospective tax changes. The increase in the tax rates introduced in the mid-1990s under the Clinton administration may have served on balance to *boost* employment, contrary to what would be predicted by the competitive equilibrium framework, because the expectation of a decline in the debt-GDP ratio boosted asset prices and thus reduced firms' markups.

APPENDIX

The Dynamic System of the Turnover-Training Model

A simple dynamic system to back the story in Figure 4 is the open economy model in Hoon-Phelps (1992) and Phelps (1994). The closed economy would also serve. Here, firms' assets are their employees, which are costly to train. There are rising marginal training costs. The real interest rate in terms of the economy's product is equal to the world real interest rate, r^*, which is taken to be fixed.

Output is an increasing function of "augmented" labor, $\Lambda_t N^P_t$, where Λ_t denotes labor augmentation at time t and N^P_t denotes the number of employees engaged in production rather than training. We add fixed capital in a simple way by admitting imports of equipment on short-term lease from overseas suppliers with zero transport costs. When employees move from producing to training they need the same equipment. The amount of capital per *augmented* employee, $K/\Lambda_t N$, is determined by the demand function, κ, which is decreasing in the given unit rental, $r^* + \delta$. Output per augmented employee allocated to *production* is given by $f(\kappa(r^* + \delta))$ and the rental per augmented employee is $(r^* + \delta)\,\kappa(r^* + \delta)$. Output and rental per *unaugmented* production worker are $\Lambda_t\varphi(r^* + \delta)$ and $\Lambda_t R(r^* + \delta)$, respectively.

In this setting, each identical firm, to maximize shareholder value, chooses its current hire rate, h, and its wage, v, to maximize a Hamiltonian function. That function involves the current proportion of employees engaged in training per hiree, given by $\beta(h)$, which is an increasing function of h; the mortality rate, θ; the quit rate, ζ, which is a function of the unemployment rate, u, of the current wage *expected* to be set at other firms *relative* to its own wage, v^e/v, and of nonwage income, y^W, as a ratio to its wage; the shadow price the firm optimally awards itself for every current employee, q; and its current stock of employees, N. The current-value Hamiltonian is

$$\{\Lambda_t\varphi(r^* + \delta) - \beta(h)\,\Lambda_t\varphi(r^* + \delta) - \Lambda_t R(r^* + \delta) - v \\ + q\,[h - \zeta((1-u)v^e/v,\ y^W/v) - \theta\,]\}\,N.$$

The necessary conditions for a maximum give three equations. These equations together with the equilibrium (i.e., correct-expectations) condition, $v^e = v$, yield the three basic equations of the equilibrium path. It is perhaps more convenient to express these three equations in terms of the *normalized* wage, $v/\Lambda\varphi$, the *normalized* shadow price, $q/\Lambda\varphi$, and *normalized* nonwage income, $y^W/\Lambda\varphi$. This introduces the actual and expected growth rate of Λ, to be denoted λ.

For a maximum, q must satisfy the arbitrage equation

$$\begin{aligned} d(q/\Lambda\varphi)/dt = &- [1 + h\,\beta'(h) - \beta(h) - R/\varphi - v/\Lambda\varphi] \\ &+ [\zeta\,(1-u, (y^W/\Lambda\varphi)/(v/\Lambda\varphi)) + \theta + r^* - \lambda]\, q/\Lambda\varphi. \end{aligned} \qquad (1)$$

It says that a capital gain (loss) is needed to make up any shortfall (surplus) of the marginal profitability of employees, $\Lambda\varphi\ [1 + h\,\beta'(h) - \beta(h) - R/\varphi - v/\Lambda\varphi]$, over the economic interest and depreciation entailed, which is $q\ [\zeta + \theta + r^* - \lambda]$.

The optimal wage balances the marginal benefit of a small increase of the wage rate that results from the consequent reduction in the quit rate against the marginal cost in terms of the payroll on existing employees of the same small rise of the wage rate. This gives the condition

$$\begin{aligned} v/\Lambda\varphi = (q/\Lambda\varphi)[&(1-u)\zeta_1(1-u, (y^W/\Lambda\varphi)/(v/\Lambda\varphi)) \\ &+ (y^W/\Lambda\varphi)/(v/\Lambda\varphi)\zeta_2(1-u, (y^W/\Lambda\varphi)/(v/\Lambda\varphi))]. \end{aligned} \qquad (2)$$

Here both lefthand and righthand sides have been multiplied by $v/\Lambda\varphi$ for typographical simplicity. The original righthand side gives the two effects on the quit rate of an increase in pay, both effects multiplied by the normalized worth of the quits averted. The original righthand side is equal to one.

The optimum scale of current hiring is at the point where the cost of speeding up by the amount of one new hire (as a ratio to the employee stock) would be just worth the gain per unit time from adding employees at that faster rate. The condition is $\beta'(h) = q/\Lambda\varphi$, which is convenient to write in the form

$$h = \phi\,(q/\Lambda\varphi), \qquad (3)$$

where $\phi'(q/\Lambda\varphi) > 0$. Using that, we have the equation of motion for employment,

$$dN/dt = [\phi\,(q/\Lambda\varphi) - \zeta\,(1-u, (y^W/\Lambda\varphi)/(v/\Lambda\varphi)) - \theta\,](1-u), \qquad (4)$$

where without loss of generality units are chosen such that $N \equiv 1 - u$.

The astute reader may have noticed that the above paragraph invokes "rising marginal hiring costs," which serves to ensure an interior maximum with some positive hiring, generally speaking, and always positive output. In contrast, the phase diagram in Figure 1 simplifies by invoking "constant hiring costs," so that a small jump of q induces the firms to switch their entire work forces from the producing mode to the training/orientation mode. The conclusions that are the focus are not lost if we follow instead we posit rising marginal hiring costs as in this Appendix.

The stationary loci. To obtain the Asset Price Curve, which is the stationary locus for normalized q in Figure 4 we need only set the left-hand side of equation (1) equal to zero, use (3) to substitute for h, and use (2), which implicitly gives $v/\Lambda\varphi$ as a function, say, $V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi)$. This gives the stationary locus

$$0 = -[1+\phi(q/\Lambda\varphi)\beta'(\phi\,(q/\Lambda\varphi)) - \beta(\phi\,(q/\Lambda\varphi)) - R/\varphi - V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi)] + [\zeta\,(1-u,(y^W/\Lambda\varphi)/V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi) + \theta + r^* - \lambda]\ q/\Lambda\varphi. \quad (5)$$

Given $y^W/\Lambda\varphi$, the normalized share price can be shown to be decreasing in $1-u$. With a standard Blanchard-Yaari formulation of the accumulation of nonwage income, Hoon and Phelps show that the long run relationship is also negatively sloped.

To obtain the Employment Curve we proceed similarly, setting the left-hand side equal to zero and again using (2) to substitute $V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi)$ for $v/\Lambda\varphi$. This gives the stationary locus

$$0 = [\phi\,(q/\Lambda\varphi) - \zeta(1-u,(y^W/\Lambda\varphi)/V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi)) - \theta](1-u). \quad (6)$$

Given $y^W/\Lambda\varphi$, the employment variable can be shown to be increasing in the normalized shadow price. Again, with a Blanchard-Yaari formulation, the long run relationship is also positively sloped.

Dynamics. A common short cut in analyzing dynamic systems takes the more slow-moving of the two state variables, here the non-wage income variable, to be temporarily constant and analyzes the dynamics of the faster-moving of these variables, employment, accordingly. Here, this subsystem is simply equations (1) and (4) after making the substitutions for v and h from (2) and (3):

$$\mathrm{d}(q/\Lambda\varphi)/\mathrm{d}t = -[1+\phi(q/\Lambda\varphi)\beta'(\phi\,(q/\Lambda\varphi)) - \beta(\phi\,(q/\Lambda\varphi)) - R/\varphi - V^s(1-u,q/\Lambda\varphi)] + [\zeta\,(1-u,(y^W/\Lambda\varphi)/V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi)) + \theta + r^* - \lambda]\ q/\Lambda\varphi, \quad (7)$$

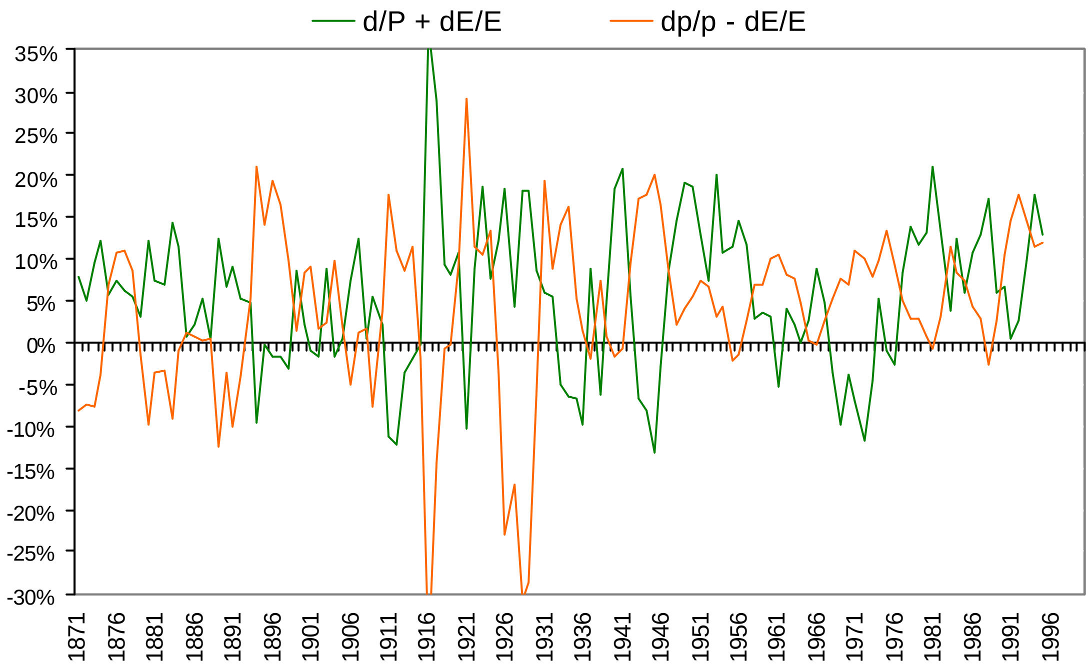
$$\mathrm{d}(1-u)/\mathrm{d}t = [\phi\,(q/\Lambda\varphi) - \zeta(1-u,\ (y^W/\Lambda\varphi)/V^s(1-u,\ q/\Lambda\varphi;\ y^W/\Lambda\varphi)) - \theta](1-u). \quad (8)$$

Analysis of this medium-run system gives the equilibrium motion along a negatively sloped "saddle path" leading (from either side) to the intersection of the Asset Price Curve and the Employment Curve corresponding to the given $y^W/\Lambda\varphi$ – dubbed here the medium-term rest point.

One kind of shock to this system is a sudden increase in the expected rate of labor augmentation, λ. Analysis of this system yields the intuitive result that such a shift of λ generates an upward shift of both the Asset Price Curve and the saddle path, hence a jump of the normalized share price, followed by a gradual sinking of that variable to its higher medium-term rest-point value and a gradual rise of employment toward its likewise higher medium-term rest-point value.

Even if real-life economies fluctuated only up and down this saddle path, there might be a reason to add a normalized stock-market indicator to the employment growth equation. Such an indicator could serve as a proxy for omitted asset stocks, such as customers and even fixed capital, which is rarely well measured.

The shock highlighted in Figure 4 brings out the major value added of a stock-market indicator. This shock is a sudden anticipation of a one-time shift at a future date in the path of productivity and thus of profits per unit of assets. That shock requires a difficult analysis with respect to the *aftermath* of the shock, since the quantum jump in productivity, once it actually occurs, has a quantum effect on the wealth-to-productivity ratio, so that ratio can no longer be held constant for analytical simplicity. But our interest is only in the existence of an expansion phase following the sudden anticipation of the future productivity shift. The reasoning to our conclusions that the asset price immediately jumps and that employment, if initially steady, will then be rising until the moment of the productivity shift appears inescapable. In such a 'bubble' scenario, a normalized stock-market indicator can serve to pick up the expectation of the future parameter shift – in our example, the productivity shift.



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