Web Appendix

for

Structural Booms: Productivity Expectations and Asset Valuation

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A boom in the customer-market model

In this model, the sudden expectation of future productivity jump generates an immediate expansion of employment (and output) in two ways. First, the resulting jump in firms' valuation of an additional customer induces firms to reduce their markups, thus foregoing profits in the near term, for the sake of adding overseas customers or regaining domestic customers in view of their increased valuation; and a cut in the markup is tantamount to the offer of an increased wage (in terms of the product domestically produced), which leads to reduced shirking and increased employment as well as increased output. This feature of our story fits nicely with the recent investment boom, especially in the US where many firms, such as Amazon.com, have been bent on expanding their stock of customers at such a speed that they have not been covering their costs (as normally measured, at any rate).

Second, at unchanged domestic real interest rates, domestic customer demand will also jump in anticipation of the future increase in productivity, which boosts their financial wealth (to the extent that they hold domestic shares) as well as their prospective future wages. As a consequence, the real exchange rate must abruptly appreciate to clear the market, given the consumption goods supplied by the domestic firms. (Domestic prices and wages in terms of comparable goods obtainable abroad must jump up so that the prospect of their gradual fall boosts the domestic real interest rate by enough to cause consumption to fall back to its original level.) This real exchange rate appreciation induces firms to moderate their markup, since each 1% increase in price is now a bigger invitation to foreign suppliers to enter, and this translates into an increase in the wage in terms of domestic product that firms judge they can afford to pay. So employment is increased on both counts and likewise the wage in terms of domestic product as the economy moves up its wage curve. These effects are eroded, however, as the economy adjusts.

For a medium-run analysis we take into account the evolution of the national firms' 'capital' – their stock of customers as a *share*, denoted x, of the domestic 'customer force' – while artificially holding constant the stock of business assets, s, that workers (i.e., households) own indirectly as the stockholders of the domestic firms – the income from which influences their shirking and thus employer costs. (Simplifying, we suppose that, before the future shock, $x_o = 1$, and

households owned just these assets, i.e., $s_o = x_o$.) In the pre-surge phase, according to such an analysis, the stock of customers will *decline* if the real appreciation implied by the consumer demand jump exceeds the real depreciation implied by the valuation jump, so that a real appreciation occurs on balance. In that case, there results a gradual loss of market share to foreign suppliers, which causes employment to subside, and a gradual end to the real appreciation; the arrival of the productivity surge causes an unchanged output to be produced with abruptly reduced employment. (This leaves the customer stock *below* where it started, but long-run analysis takes into account that workers' assets have actually been reduced correspondingly, so their consumption will not yet have increased in proportion to productivity and their shirking will be down, which will induce firms to gain back the customers lost to overseas competitors.) On the other hand, the firms' market share will *expand* if instead the real depreciation implied by the valuation jump exceeds the real appreciation implied by the consumption demand jump, so that a real depreciation occurs. There is a statistical association between the strengthening of the real exchange rate and the other signs of a general investment boom in the late 1990s, as Figure 3 shows. So it may be that the parameter patterns required for this latter scenario are seldom found empirically.

A boom in the turnover-training model

This model's property of rising marginal hiring costs in standard formulations injects a friction that slows down the employment response to present shocks but advances in time the response to the expectation of future shocks. The sudden expectation of the future jump of productivity prompts firms immediately to commence additional hiring, since, up to a point, smoothing of the firm's hiring helps to reduce the total discounted cost of the necessary training of new recruits.

We would note that an unanticipated and immediate increase in the expected *trend-rate* of technical progress (as measured by the rate of labour augmentation) is a shock having quite different effects. It operates like a drop of the expected real interest rate: it boosts the present discounted value of every employee, existing or additional, and in so doing permanently shifts the 'rest point' to which the economy gradually converges.

Econometric issues

The implication of the foregoing discussion is that asset valuations belong in the employment growth equation or unemployment equation (where lagged unemployment is on the right-hand side). That implication may seem trivial, obvious beforehand. Students of dynamic systems know that, as Miles Kimball puts it, the state variables (K, $1 - u$, …) tell us all we need to know about the past and the costate variables (our q's) tell us all we need to know about the future. So *of course* the q's belong in our employment equations. Yet some may feel that such a conclusion is superficial since, in systems that are stationary, even if brushed by the occasional temporary shock, the q's are derivable functions of the state variables and the parameters. No wonder a generation of macroeconomists have not judged it promising to add asset prices to their equations.

The issue can be resolved easily. Clearly it would be a mistake to say that the

increased valuation sparked by a *sudden and unprompted shift in expectations* is in any sense the *cause* of the expansion of employment; the valuation is only the endogenous variable that transmits the effect on employment. But if there are no prior clues to the shift of expectations in the *standard* macroeconomic and other data among our explanatory variables, it is well justified to supplement those variables with a valuation variable or a surrogate for valuations that can be regarded as a *proxy* for the expectations shift not revealed in the standard observable data. Prevailing statistical practice is quite right in excluding forward-looking expectational variables in circumstances where there is ample reason to think that the explanatory variables already in use do a satisfactory job of capturing such expectations.

Improved expectations about the future *trend* growth rate of productivity are apt to be inspired by recent experience of an *actual* and observed acceleration of productivity in the recent past; the new expected growth rate of productivity will be captured by the actual rate of productivity growth observed in the recent past. The kind of technological shock termed a *future surge* in the time path of productivity at some *future date* seems particularly in need of data on asset valuations to capture it.

So the 'value added' by having managers' valuations of business assets in the employment equation is that they would capture the confidence or despair that managers feel about forthcoming developments and what they will mean for the profitability of their business assets. It is only if the asset valuations are always in a fixed relation to the state variables and observable parameters that nothing is gained from having them in the equation.

With the above as background several other issues can be quickly resolved. One is whether the asset valuations are sufficient, depriving all the conventional variables from any explanatory role in the employment growth equation. The general answer is that since employment growth involves the quit rate, which in turn involves the unemployment rate, non-wage income and benefits, and the after-tax wage, it is immediately clear that those variables and, in the case of the wage, the variables determining the wage have a rightful place in the equation.

It might nevertheless be thought that it makes no sense to retain, in particular, the cost of capital, $r^* - \lambda$, in the employment growth equation, since presumably q^N reflects the cost of capital as well as profits. The truth is that while q^N surely does reflect the cost of capital, r^* matters for the after-tax wage rate not only indirectly through q^N but also directly through its impact on the net-interest-and-depreciation terms appearing in the equation for the demand wage, which has an impact on quitting. (Interestingly this implies that q^N enters the employment equation once independently of r^* and again in interaction with r^*.)