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Comments on James Bessen's "Technology Adoption Costs and Productivity Growth: The 70's as a Technological Transition"

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J. Bessen introduces adjustment costs of investment into an otherwise standard production setting. The fraction of output lost from implementing investment is proportional to I_{t-1}/K_{t-1}. Therefore, variations in adjustment cost enter into the Solow residual as in his equation (6). The paper has four main results: (1) adjustment costs are large; (2) they increased in the 1970s; (3) this increase was primarily associated with the arrival of information technologies; (4) the magnitude of these adjustments was so large that they caused the productivity slowdown in manufacturing. I have some doubts about each of these results, as I shall now explain.

1. ARE ADJUSTMENT COSTS LARGE?

To estimate the magnitude of the adjustment costs, Bessen (2001) regresses the growth rates of TFP on the lagged change of the investment–capital ratio. He uses the lag structure to avoid reverse causality problems. However, it is well known that when the dependent variables are serially correlated, lagging the independent variables may not be sufficient. This is one potential concern in this context. The growth rate of TFP shows mean reversion (i.e., serial negative correlation).[2] So, the negative

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[2] The exact regression I run is as follows. The dependent variable is annual TFP growth rate corrected for capacity utilization as described below. The independent variables are the one-year lag in the growth rate of TFP corrected for capacity plus time and sector specific dummies. The coefficient on lag TFP growth is −0.0922 with a standard error of 0.0078.

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coefficient of the lagged change of I/K on TFP growth can be due to the positive contemporaneous effect that innovations in TFP growth may have on investment and the mean reversion in TFP growth.

To address this issue, Bessen argues that changes in investment Granger-cause productivity growth. There are two problems with the conclusion that Bessen draws from this test. First, the null hypothesis that Bessen should test to make his point is that TFP growth does not Granger-cause changes in the investment–capital ratio. This hypothesis can be rejected at the 5% significance level. Second, it is well known (e.g., Hamilton (1994, p. 308)) that Granger-causality tests have a hard time uncovering causal relationships when the relationship between the two variables is forward looking. This is an important concern in this context since, presumably, investment reacts to (anticipated) future productivity shocks. In this sense, the results from Bessen's test can only prove that investment innovations predict future TFP growth.

2. DID ADJUSTMENT COSTS REALLY INCREASE IN THE 1970S?

Another issue is the robustness of the results to some variations in the specification. The results seem robust to weighting the sectors by value added. The 1970s are a period where economic activity was disrupted for many other reasons in addition to the acceleration of the diffusion of information technologies. Some of these shocks caused substantial cyclical movements that might have had asymmetric effects across sectors. To control for this, it is interesting to correct the TFP growth series for changes in capacity utilization. I do this by subtracting from TFP growth the growth rate in materials times the capital share in the sector. I denote this variable by "cTFPg." Bessen's estimate of the effect of the change in the investment–capital ratio on the TFP growth is robust to the correction for capacity when the sample period is 1958–1996. However, his estimates for the subsamples are not robust. This is illustrated in Table I.

Hence, after correcting for capacity utilization (see Table I), the positive increment in the size of the adjustment cost that Bessen found for the 1970s disappears. This means that in the 1970s what happened was not that it was more costly to implement new capital but something else. To investigate the nature of these mechanisms, we can regress the capacity adjustment (i.e., capital share times the growth rate of materials) on capacity-adjusted TFP growth and the lagged change in the investment–capital ratio. With this regression, we can visualize two mechanisms that may be responsible for what Bessen identifies as an increase in the adjustment costs during the 1970s.

TABLE I
Robustness to Correction for Capacity Utilization in Subsamples
(Dependent Variable TFP Growth with and without Correction)

Utilization correction	No	No	No	Yes	Yes	Yes
$\Delta I/K(t-1)$	−0.106 (0.0147)	−0.212 (0.033)	−0.115 (0.0262)	−0.116 (0.015)	−0.166 (0.034)	−0.0595 (0.026)
$\Delta I/K(t-2)$	−0.078 (0.0155)	−0.185 (0.0348)	−0.068 (0.029)	−0.092 (0.016)	−0.101 (0.035)	−0.0473 (0.03)
$\Delta I/K(t-3)$	−0.065 (0.0152)	−0.11 (0.0326)	−0.036 (0.0317)	−0.075 (0.015)	−0.026 (0.033)	−0.0475 (0.03)
Sample period	<1974	1974–1983	>1983	<1974	1974–1983	>1983

Note. All regressions include time dummies and sector fixed effects, as in Bessen's original regressions. Standard errors in parentheses.

First, the relationship between the increase in the investment–capital ratio and the rate of capacity utilization is negative. Therefore, part of the acceleration detected by Bessen just reflects the fact that, in the 1970s, increases in the investment–capital ratio induced larger declines in capacity utilization than in the 1960s. Second, corrected TFP has a negative effect on capacity utilization.[3] This means that, after an acceleration of I/K that depresses corrected TFP growth, the associated increase in capacity crowds out part of the decline in TFP growth. This is relevant to understanding the reported acceleration of the adjustment costs in the 1970s because the crowding-out mechanism was stronger in the 1960s. Hence, both the direct effect and the indirect effect of the change in the investment–capital ratio on capacity indicate that firms tended to reduce more capacity after investing heavily. This higher elasticity may be related to the novelty of some of the investments in the 1970s or to other factors such as the uncertain economic environment. This is studied more carefully in the next section. However, even if the first hypothesis is true, it reveals something about the nature of the adjustment costs. They are the same frequency as capacity utilization. Since capacity has no medium-run trend, the adjustment costs are not a likely explanation for any medium-run process like the productivity slowdown.

3. ARE THE ADJUSTMENT COSTS ASSOCIATED WITH IT?

To further investigate the nature of the adjustment costs, I study whether the change in the investment–capital ratio is related to computers both in

[3]This is consistent with the contractionary effect of technology shocks found by Gali (1999) and Basu and Fernald (1995).

TABLE II
Explaining Variation in Capacity Utilization (Dependent Variable: Capacity Correction (Capital Share Times Growth Rate of Materials))

cTFPg	−0.17	−0.2086	−0.145	−0.158
	(0.004)	(0.007)	(0.0075)	(0.007)
$\Delta I/K(t-1)$	−0.019	−0.0115	−0.0267	−0.053
	(0.006)	(0.008)	(0.0151)	(0.012)
Period	1958–1996	<1974	1974–1983	>1983

Note. Standard errors in parentheses. All regressions include time and sector dummies.

the cross section and in the time series. The sector intensity of computers is measured by the share of office computing and accounting machines (OCAMsh) in total investment and by the share of computers in total investment. Table III reports the cross-sectional correlations for 1967, 1977, 1982, and 1987. The correlations range from −0.0189 to 0.065 and from −0.15 to 0.12 when the sectors are weighted by their value added. These figures are quite low, given the important role Bessen assigns to computers when interpreting his results.

The time series shows no relation between the change in the investment–capital ratio and the intensity of computers. To show this, I run fixed-effects panel regressions with time dummies for the same years as in Table III. The coefficient of the share of computers and the share of OCAM on the increment in investment–capital ratio is −0.0066 for computers and 0.026 for OCAM, with t-statistics of −0.226 and 0.255, respectively. Therefore, the RHS variable included in Bessen's regressions in Tables I and II does not seem to be related to investments in computers or related equipment.

Bessen then uses the BLS dataset to show that the change in the ratio of IT capital to total capital has a significant negative impact on TFP growth. However, more careful examination indicates that this relationship cannot be due to the high cost of adopting computers in the 1970s. By running

TABLE III
Cross-Sectional Correlation between $\Delta I/K$ and Computers

	No weights	Value-added weights
Corr(OCAMsh67, $\Delta I/K67$)	0.0423	0.003
Corr(OCAMsh77, $\Delta I/K77$)	0.0584	0.108
Corr(computer share 77, $\Delta I/K77$)	0.0646	0.097
Corr(computer share 82, $\Delta I/K82$)	0.0144	0.12
Corr(computer share 87, $\Delta I/K87$)	−0.0189	−0.156

TABLE IV

Effect of $\Delta K^{IT}/K$ on TFP Growth (Dependent Variable TFP Growth)

Period	1960–1996	<1974	1974–1983	>1983
$\Delta I/K(t-1)$	−0.183	−0.417	−0.049	−2.15
	(0.132)	(0.163)	(0.27)	(0.294)
$\Delta K^{IT}/K(t-1)$	−1.65	−7.83	−0.93	−1.2
	(0.536)	(2.78)	(1.23)	(0.936)

Note. Standard errors in parentheses. All regressions include time and sector dummies.

the same regression for the three time periods analyzed in the paper, we find that the correlation between the change in the ratio of IT capital to total capital and TFP growth exists only in the 1960s. This correlation is nonexistent in the 1970s and 1980s.[4] See Table IV.

4. DOES THE INCREASE IN ADJUSTMENT COSTS ACCOUNT FOR THE PRODUCTIVITY SLOWDOWN?

So far, I have raised important doubts about the size of the adjustment costs based on their evolution and on whether they are associated with the adoption of computers. But, even if one buys Bessen's regressions, it is not clear that the implied correction to TFP growth is the one he reports (Bessen (2001, Table 5)). The main reason for that is that when Bessen evaluates his equation (10) he uses the change in the ratio of the average investment to the average capital stock instead of the change in the average investment–capital ratio. In a private communication, Bessen argued that this is a way to deal with outliers. However, the most natural way to deal with outliers is probably to use the median in the change in the investment–capital ratio, since at least this is the variable used in the regression. Moreover, it is not clear why outliers suddenly become a concern. These considerations are important because the corrections implied by Bessen's regression are much smaller than those in Bessen's Table 5, as can be seen in Table V.

The small adjustment costs reported in Table V are just the consequence of the small average and median values of the change in the investment–capital ratio in the data. This means that the adjustment costs studied by Bessen are of little relevance for medium-run phenomena such as the productivity slowdown.

[4]This result is robust to the inclusion of a square term of $\Delta K^{IT}/K$ as a regressor.

TABLE V
Corrected TFP Growth

	1949–1973	1974–1988	1974–1988	1961–1973	1961–1973	1974–1983	1974–1983
dZ/dt – BLS MFP growth	**1.52%**	**1.13%**	**1.13%**	**1.84%**	**1.84%**	**0.52%**	**0.52%**
Adjustment costs from							
NBER–CES data		Median	Mean	Median	Mean	Median	Mean
dc/dt		–0.033%	–0.057%	0.0183%	0.0036%	–0.0690%	–0.0950%
Adjusted TFP growth: $Z + dc/dt$		**1.097%**	**1.063%**	**1.8580%**	**1.8436%**	**0.451%**	**0.425%**

Source. Author's calculations based on Bassen's (2001) estimates and NBER–CES data.

CONCLUSIONS

I have argued that the costs of adjusting to more computer-intensive production techniques were not an important factor in the productivity slowdown observed in manufacturing during the 1970s. This is consistent with my own findings (Comin (2000)) that the availability of flexible technologies such as computers helped alleviate the productivity slowdown in the 1970s. McHugh and Lane (1987) also found that during the 1970s new capital was particularly productive (as compared to the 1960s). This evidence implies that the search for culprits should be somewhere else. The new technologies arrived at the scene of the crime at the worst moment, but were not guilty. The old technologies are a clear suspect. Something might have happened that made them suddenly obsolete. Oil was not sufficiently important as a share of gross output to generate such a large slowdown. In Comin (2000), I argue that the critical shock might be related to the increase in uncertainty. This made inflexible capital obsolete. Firms wanted to shift to new flexible capital. This explains the finding by McHugh and Lane and the investment boom in the late 1970s and early 1980s. Though this debate is not settled yet, at this point one thing seems quite clear: computers did not hurt the U.S. economy in the 1970s.

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