Aggregate Investment: Lessons from the Previous Millenium

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AEA Session. In Memoriam: Robert Eisner

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In his 1978 book: "Factors in Business Investment," published by the NBER, Bob Eisner summarized much of his work on investment. The opening paragraph of the book's introduction captures well why investment is bound to be a perennial topic in economics: *"Few economists or business analysts need be reminded of the importance of investment. First, investment contributes to future output; net investment to economic growth. Second, it contributes to current demand and current employment. Understandably, there is much sentiment for encouraging investment, or at least for removing discouraging influences, to permit these contributions to be optimal."*

Modern developments in growth theory and macroeconomic models with financial-multipliers, have only leveraged his introductory remarks.

But while we all may agree on the importance of investment for a nation's economic health, our understanding of its determinants, both at the microeconomic as well as the

macroeconomic level, has remained limited. The empirical investment literature has been nearly merciless in evaluating investment theories. Bob Eisner was an outstanding empiricist, and as such he is responsible for many of the blows asserted on these theories.

One of Eisner's favorite targets was, in his words, "the so called neoclassical theory of investment." He favored quantity-accelerator over price-mechanisms, and had substantial evidence to support his position. In his 1978 book, he promoted demand polices rather than supply-side mechanisms to reinvigorate an economy in the short run. When Bob Gordon invited me to participate in this session, his mandate was to "settle" the Eisner-Jorgenson dispute… I was flattered… but I'm not naïve enough to believe I'll succeed in doing so.

It is, however, a great excuse to briefly review recent developments in the investment literature. I'll do this below, while developing three sub-themes. The first two are directly connected to the investment literature, while the last one has to do with the ongoing process of creative-destruction, the ultimate investment process in a dynamic market economy:

1. Does the cost of capital matter for investment?

This is a perennial debate, re-ignited by Eisner and Jorgenson during the 1960s, and further fueled during the 1980s when the newly-minted q-theories --close cousins of the neoclassical models, as Abel (1979) and Hayashi (1982) would show-- joined models which were based on cost of capital in their lack of empirical success. The 1980's

discontent with respect to investment equations is probably best represented by this statement from Blanchard's (1986) discussion of Shapiro's (1986) investment paper at Brookings:

"… it is well known that to get the user cost to appear at all in the investment equation, one has to display ***more than the usual amount of econometric ingenuity****; resorting most of the time to choosing* ***a specification that simply forces the effect to be there****…."* [my emphasis]

Today, the first emphasized statement still holds, but the second one probably does not. Econometric "ingenuity" eventually pays off, although this often means isolating that part of the relationship that conforms with the theory, rather than explaining a substantial fraction of the movements of the left-hand side variable, or even relating a significant fraction of the volatility of the right-hand side variables to that of the left-hand side variable. In my view, this is the type of payoff obtained by many of the recent successful attempts. Still, it is progress.

There are essentially two types of developments within what I like to refer to as "traditional" investment equations, by which I mean more or less standard linear investment equations derived from some representative agent problem facing quadratic adjustment costs.

The first of these types of developments simply gives up on trying to understand short-run dynamics and adjustment costs, and estimates directly the long run relationship

between capital (the integral of investment) and its cost. There are a series of econometric issues to deal with, but the essence of the main finding is easily understood. The cost of capital, which includes not only the cost of borrowing or investing in alternative activities but also taxes and subsidies, has experienced large and persistent changes over time – both at the aggregate level and across sectors--- while the capital-share has remained more or less unchanged. This suggests that, in the long run at least, cost of capital does matter for investment, and it does so with an elasticity not very far from one.[1]

The second type of development is a bit more ambitious but not entirely unrelated in method. It also ignores the great majority of changes in investment and focuses on episodes of tax-reforms, when the right hand side variable has had large changes so the signal is clear. Degrees of freedom are recovered by resorting to firm level rather than aggregate data.[2] Here again, the finding is that cost of capital measures as well as *q* have coefficients many times larger than is normally found.

I think it is not too unsafe to conclude from these findings that investment is indeed responsive to changes in cost of capital, at least when the latter are persistent and large enough. The problem, unfortunately, is that such changes leave lots of the variation in aggregate and microeconomic investment unexplained.

[1] Caballero (1994)
[2] Cummins, Hassett and Hubbard (1994).

2. What do lumpy and irreversible investment theories have to say about aggregate investment behavior?

I believe that the main reason the investment literature does so poorly empirically is that adjustment frictions are vastly more complex than we have modeled. Of course this is true of almost everything we do in economics, but it seems to be worse for investment. One shouldn't forget that investment is a flow, and as such it is very sensitive to obstacles on the underlying stock-adjustment. Investment is the by-product of the process by which the capital stock catches up with its desired level, but there are many obstacles in its path. Most importantly, these are not equally important at all times and in all states of the world, hence the relationship between investment and its driving forces is highly unstable… at least when we look at it with our simple linear structures. This source of headache for previous theories has been a source of inspiration for new theories, which have identified many of its mechanisms from the time and state variation of the relationship between investment and its driving forces. This is the case of theories based on nonlinear microeconomic adjustment due to fixed costs and irreversibility.

There are essentially three types of adjustments observed at the establishment level: (a) ongoing frictionless flow (maintenance); (b) gradual adjustments (e.g. refinements and training dependent improvements); (c) major and infrequent adjustments.[3] Incidentally, Bob Eisner was very keen on separating investment between maintenance-driven and expansion-driven.

The structural literature prior to and during the 1980's, based explicitly or implicitly on convex adjustment cost models (the quadratic adjustment cost model, in particular) dealt with (a) and (b). The implicit "hope" was that the smoothness brought about by aggregation would make disregarding the importance of infrequent adjustments for individual units unimportant for aggregate phenomena. The idea was to derive aggregate investment equations as coming from the solution to the optimization problem of a fictitious agent facing adjustment costs which only led to smooth adjustments of type (a) and (b). Many authors disagreed with this strategy (e.g. Rothschild 1971); but for most the relative simplicity of the quadratic model was too enticing to resist.

A combination of factors eventually led economists to revisit and reevaluate some of the shortcuts which were in widespread use by the end of the 80s.[4] First, there was frustration with the disappointing empirical results described above. Second, techniques which could handle models of lumpy investment became part of economists' tool kit. And third, microeconomic data made the obvious even more apparent: microeconomic investment is extremely lumpy, and this lumpiness is unlikely to fully "wash out" at the aggregate level.

The work of Doms and Dunne (1993) was instrumental in stressing the last point. They documented the investment patterns of 12,000 U.S. manufacturing plants over the 17 year period, 1972-89. Their findings are many, of which I have chosen to emphasize those that are most closely related to the purpose of this note.

[3] Which may, in turn, have a time to build aspect.

For each establishment, Doms and Dunne constructed a series of the proportion of the total equipment investment of the establishment (over the 17-year period) made in each year. They found that, on average, the largest investment episode accounted for more than 25 percent of the total 17-year investment of an establishment and that more than half of the establishments exhibited capital growth close to 50 percent in that single year. They also noted that the second largest investment spike often came next to the largest investment spike (right before or right after) suggesting that both spikes correspond to a single investment episode.[5] Combining the two primary spikes, they found that nearly 40 percent of the sample investment of the median establishment probably corresponds to a single investment episode.

In Caballero, Engel, and Haltiwanger (1995) we characterized this pattern further by documenting the connection between the occurrence of these spikes and the underlying stock-gap of the establishment. Figure 1 documents our main finding in this regard. It clearly shows that as the shortage of capital with respect to a well defined neoclassical target rises, the probability of an investment episode also rises. It also shows that establishments have more difficulty reducing than increasing their stock of capital.

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[4] Cronologies are never exact, of course. For example, Nickell had already discussed irreversible investment and many of its implications in 1978; but the mode did not move until much later.

[5] An investment project may not be fully counted within one year since not all projects start on January 1, and certainly may take more than a few days to implement. One should not confuse ‘‘time to build" with the standard convex adjustment costs. Time to build is the optimal scheduling of a given lumpy project, while in the standard convex adjustment costs model the firm changes this project continuously and smoothly (see Caballero and Leahy 1996).

What aspect of the data makes these models better than linear ones at explaining aggregate investment dynamics?

The simplest answer comes from an example. Suppose that a history of mostly positive aggregate shocks displaces the cross sectional distribution of imbalances toward the high part of the hazard. Such a sequence of events will not only lead to more investment along the path but also to more pent-up investment demand; indeed, the cross sectional distribution represents unfulfilled investment plans. But as unfulfilled demand ‘‘climbs” the hazard, more units are involved in responding to new shocks; incremental investment demand is more easily boosted by further positive aggregate shocks, or depressed by a turnabout of events. This time-varying/history-dependent aggregate elasticity plays a very important role for aggregate investment dynamics. It captures the aggregate impact of changes in the degree of synchronization of large adjustments. This is already an important explanatory variable in Doms and Dunne’s less structural study, in particular, in their observation that the Herfindahl of investment rises during episodes of large aggregate investment.

Using the path of cross sectional distributions and hazards estimated for U.S. Manufacturing, Caballero, Engel and Haltiwanger (1995) found an important role for the mechanism described above. Figure 2 depicts the relative contribution of the time-varying aggregate elasticity for aggregate investment dynamics. A positive value reflects an amplification effect (micro-nonlinearities exacerbate the economy’s response to aggregate shocks), while a negative value reflects an offsetting effect. The impact of the

time-varying elasticity appears to be especially large after the tax-reform of 1986 (when tax-incentives for investment were removed). The decline in investment was 20 percent greater than it would have been under a linear model.

3. What about the accelerator and financial constraints?

Indivisibilities, fixed costs, and irreversibility are not the only frictions to stock-adjustments. Financial frictions ---which are in many ways leveraged by the above frictions, I might add--- are central to the investment literature and to the accelerator model in particular.

In his 1978 book, Bob Eisner was very careful about the many potential interpretations of the "sales" and "profit" variables on the right-hand-side of investment equations; do they reflect expectations of future profits? Or ready availability of cash flows and hence the relaxation of financial constraints? The attempt to disentangle these factors remains an active industry today. My reading of the literature is that while there is no single conclusive piece of evidence in favor of financial constraints in the U.S., there is a large accumulation of highly suggestive evidence for them. Surely there are findings of the opposite… but these happen less than five percent of the time so we can relax about them…

On the theory side, we have seen a welcome avalanche of macroeconomic models where microeconomic financial constraints lead to well defined aggregate amplification and

persistence mechanisms. The role of collateral and its endogenous value has leveraged many times already powerful mechanisms. The point I want to make in closing, nonetheless, is that the modern accelerator models probably underestimate significantly the cost generated by financial constraints during recessions.

The costs of prolonged depressed investment, now defined more broadly than just investment in new equipment and structures, go beyond the level effect emphasized by the accelerator model. Modern market economies experience an ongoing process of restructuring which is central to economic growth and prosperity, as forcefully advocated by Schumpter and others. When financial resources limit the recovery of investment and modernization, the whole process of restructuring is affected.

Mohamad Hammour and I have tried to gauge these costs by studying the behavior of job creation and destruction in U.S. manufacturing. The connection with the investment series is tricky and it probably requires broadening the concept of investment to include asset-reshuffling as well, but let me ignore that for now.[6] Our main findings are summarized in figure 3. Panels (a) and (b) of figure 3 portray the estimated impulse-response function of (minus) employment and job flows, respectively, to a 2-standard-deviation recessionary shock. As is well documented by Davis-Haltiwanger-Schuh, at impact job destruction rises sharply and job creation declines to a lesser extent. Less known is what comes next. Along the recovery path, job destruction declines and falls below average for a significant amount of time, offsetting its initial peak. On the other hand, job creation recovers to its average level but does not exceed it to any significant

extent to offset its initial decline. We dubbed this finding, the chill effect of recessions, and we attributed it largely to the limited availability of financial resources during the recovery.

In the words of these notes, the accelerator model that we seem to observe in U.S. manufacturing, at least when measured indirectly through job flows, is such that not only cummulative new investment is depressed during recessions but it also doesn't come back to pre-recession levels even after the whole recovery has taken place. This decline in the restructuring process of an economy that already churns too little –or used to, shall I say— is very costly. We concluded that it increases the cost of recessions by about 30 percent over what one infers, from example, by just counting cumulative unemployment times average labor productivity.

Taking stock

Would Bob be happy with the new developments in the investment literature? He probably had an opinion on this, which I unfortunately didn't have the chance to hear. But I would have tried to convince him, if the need arose, that he should have. Not only his growth and business cycle motivations are as relevant today as they were in the 1970s, but also the many frictions to dynamics, many of which he foresaw, are understood a lot better today. Pent-up demand, the accelerator, and other evocative terms of the investment literature of a few decades back… have largely regained their respectability, although many times disguised in new jargon.

[6] Caballero and Hammour (1999).

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Figure 1

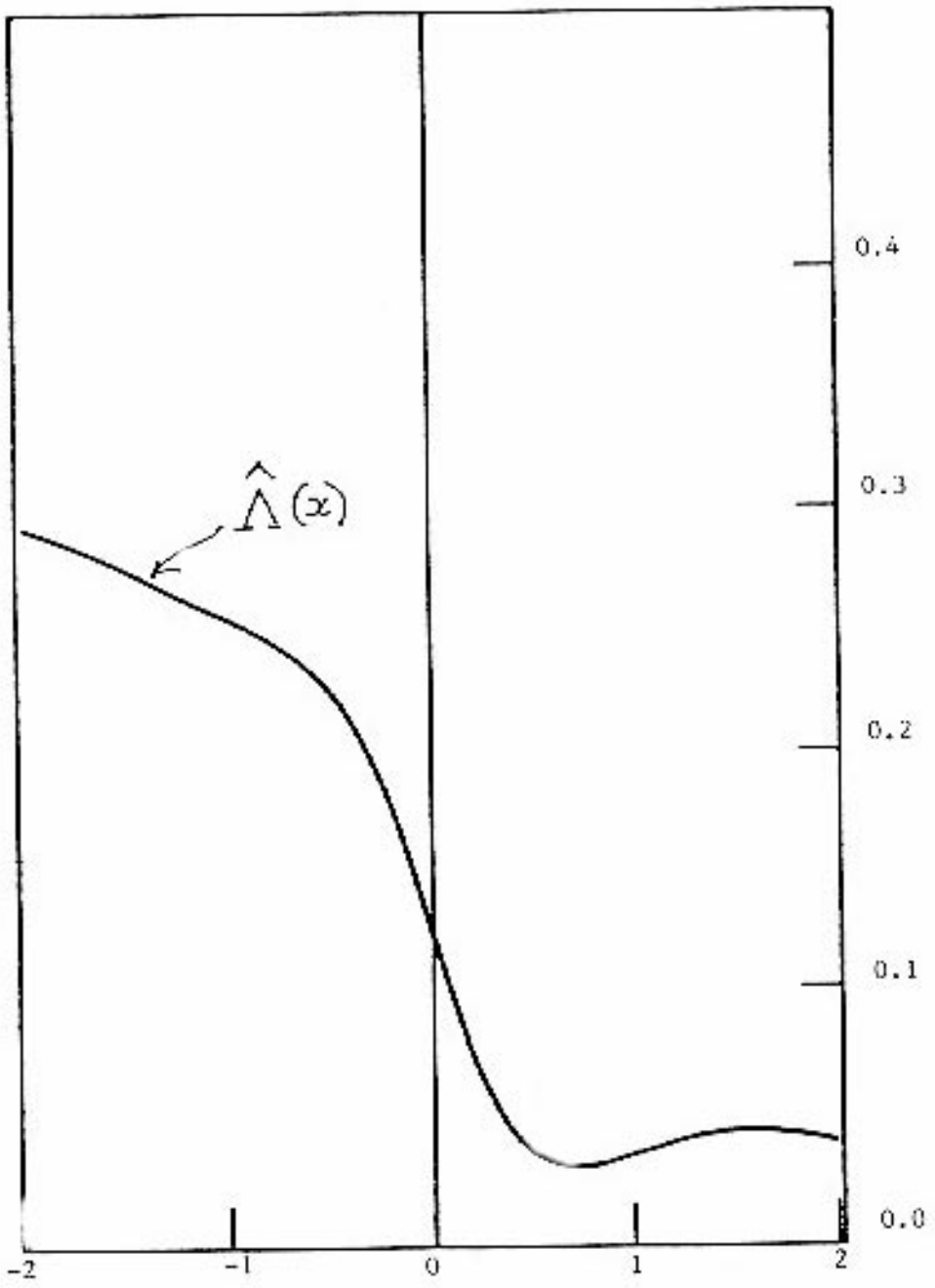

Figure 2

Relative Contribution of Time-Varying Marginal Response, 1974–88

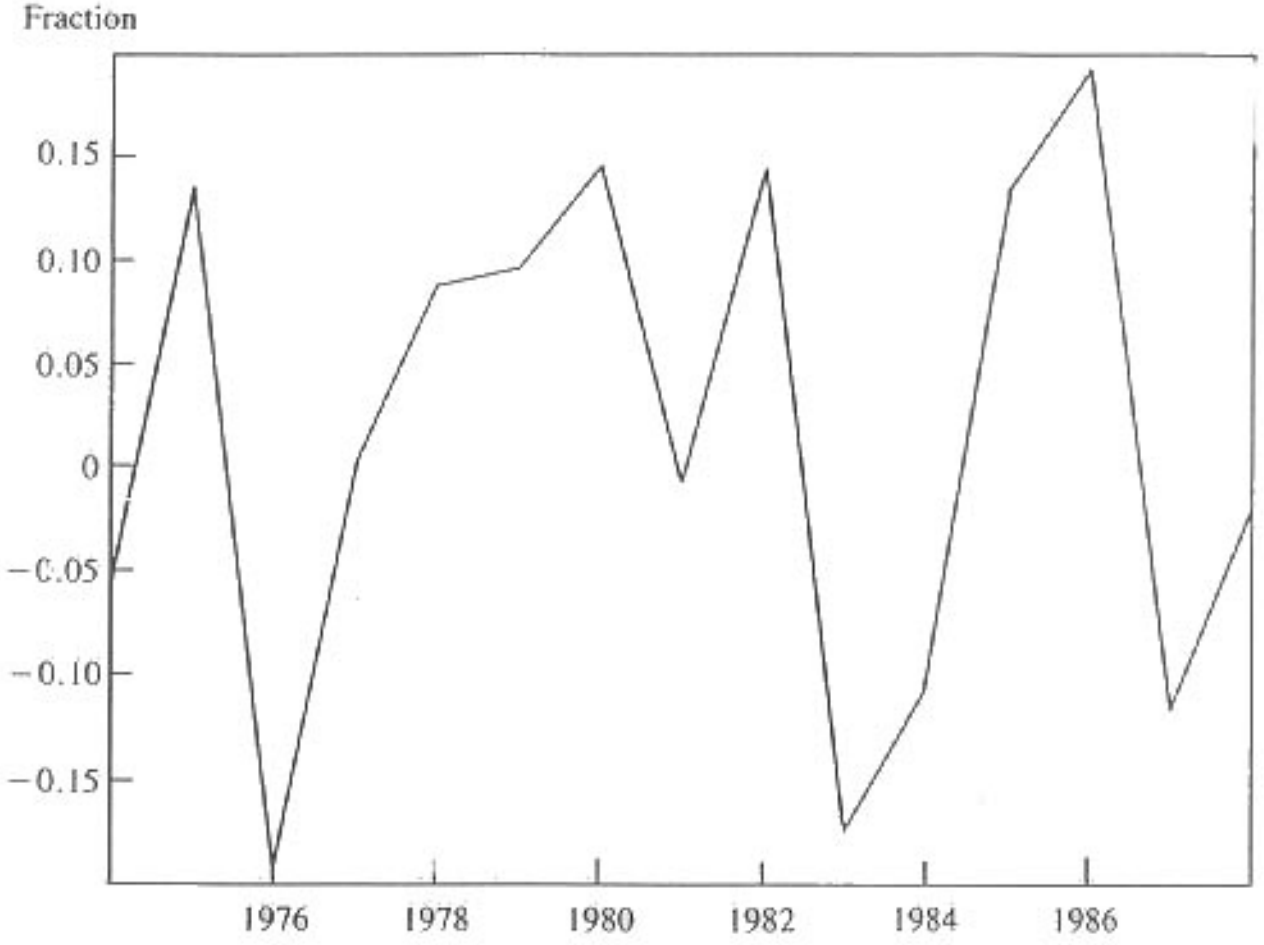

Figure 3.2a
Impulse response (single factor): (minus) Employment

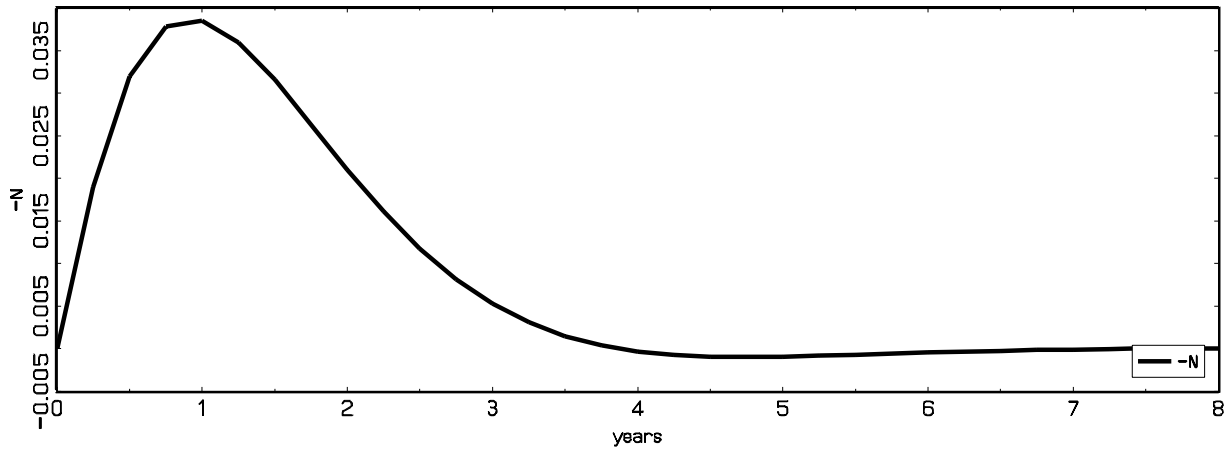

Figure 3.2b
Impulse Response (single factor): Job Creation and Destruction

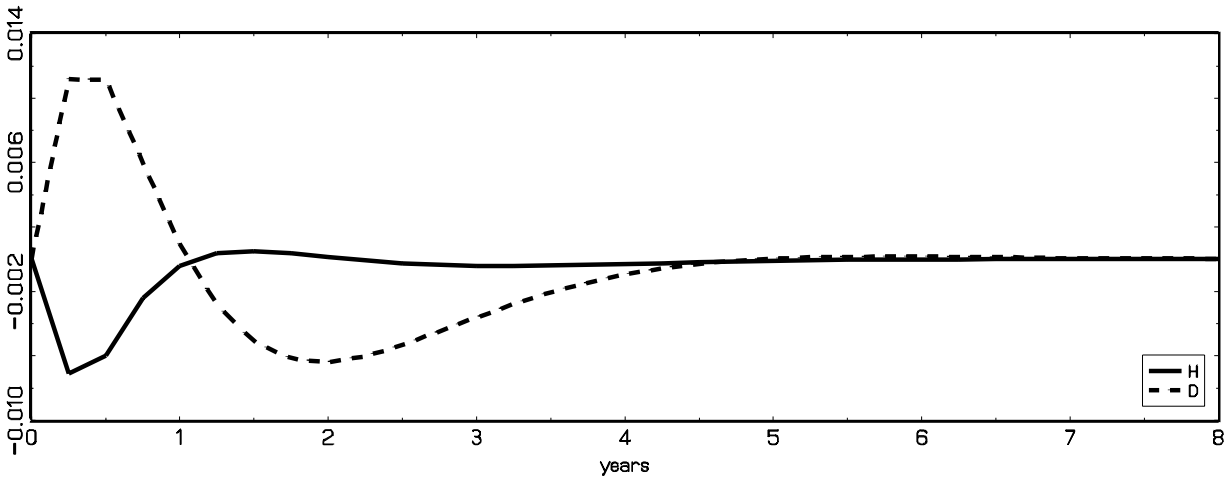

Figure 3.2c
Impulse Response (single factor): Cumulative Job Creation and Destruction