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GLOBAL VERSUS COUNTRY-SPECIFIC PRODUCTIVITY SHOCKS AND THE CURRENT ACCOUNT

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ABSTRACT

The intertemporal approach to the current account is often regarded as theoretically elegant but of limited empirical significance. This paper derives highly tractable current account and investment specifications that we estimate without resorting to calibration or simulation methods. In time-series data for eight industrialized countries, we find that country-specific productivity shocks tend to worsen the current account, whereas global shocks have little effect. Both types of shock raise investment. It is a puzzle, however, for the intertemporal model that long-lasting local productivity shocks have a larger impact effect on investment than on current account.

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I. Introduction

Current account imbalances are frequently at the center of international policy controversy. One might expect that the modern intertemporal approach to international finance, which stresses how current accounts depend on aggregate saving and investment decisions, would be quite helpful in informing this debate. But, in fact, most applied work continues to focus on income and price elasticities of demand and partial equilibrium effects.[1] Part of the problem is that to date, empirical implementation of intertemporal current account models has been rather limited.[2] The models are difficult to estimate by conventional methods in part because it is not clear how best to reduce them to tractable estimating equations. A number of researchers have applied real business cycle parameterization techniques to international data,[3] but although valuable, these exercises cannot fully substitute for broader and more direct hypothesis testing.[4]

In this paper we develop a version of an intertemporal current account model with adjustment costs to investment and apply it to data for eight countries over the years 1961-90. The framework developed in Section II is sufficiently tractable that we are able to estimate investment and current account equations directly in Section III, without resorting to the simulation or the imposition of parameter restrictions. Our model adopts the real business cycle emphasis on productivity shocks, but allows countries to insure against

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[1]See, for example, Krugman and Baldwin (1987), Lawrence (1990), and the references therein.

[2]A notable exception is Ahmed (1986), who tests an intertemporal model of the effects of government spending on the current account on historical data for Great Britain. He does not, however, incorporate investment into his analysis, which is central to the issues we address here.

[3]See, for example, Backus, Kehoe and Kydland (1992), Baxter and Crucini (1992), and Stockman and Tesar (1990).

[4]Overall, it is probably fair to say that the representative international economist remains skeptical whether intertemporal models are empirically central to practical current account issues: "... I am impressed with the near complete sterility of the intertemporal approach in the face of actual policy issues" (Dornbusch, 1988, p. ix).

country-specific shocks only via the option to issue international bonds.[5] A central feature of our empirical approach is the distinction between global and country-specific shocks. The results are consistent with the prediction that both types of shocks impact on investment, but only country-specific shocks have a significant impact on the current account. They appear robust to allowing for various measures or productivity, as well as to allowing for government spending shocks.

The data nevertheless reveal an important puzzle. A strong implication of the intertemporal model is that a permanent country-specific productivity shock will induce a rise in the current account deficit in *excess* of the corresponding rise in investment. Because it takes time for the capital stock to adjust in response to a permanent productivity shock, permanent income rises by more than current income; this implies that domestic savings should fall. Obviously the response of domestic saving would be reversed if the shock were (sufficiently) temporary. Empirically, however, we find that country-specific productivity shocks damp slowly if at all for the major industrialized countries. Thus it is something of a puzzle that even after controlling for global shocks, the current account response to country-specific productivity shocks is typically less than half the investment response.

We conclude the paper by relating our results to an earlier literature, stemming from Sachs (1981, 1983), that explores nonstructural regressions of the current account on investment in an effort to test for capital market integration. We show that the importance of global shocks goes a significant way towards rationalizing the small coefficients one obtains in these types of regressions.

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[5]The restriction that the main way countries insure is via issuing riskless bonds is standard in much of the theoretical literature; see, for example, Obstfeld (1986) or Frenkel and Razin (1987), and the extensive references therein. It is possible that this assumption might be justified by appealing to asymmetric information, as in Gertler and Rogoff (1990), but we do not explore the issue here.

II. A One Good, Small-Country Model with Adjustment Costs to Investment

In this section we develop a structural model in which investment and the current account depend on exogenous shocks to productivity. The basic building blocks--a model of investment with adjustment costs and the random walk model of consumption--are quite familiar so our discussion of individuals' and firms' maximization problems will be quite brief. We will show that by using a linear-quadratic approach, one can obtain extremely tractable estimating equations for investment and the current account. For the moment we will postpone including a government sector.

A. Capital Markets

Our model is of a small country where the representative agent can borrow freely in world capital markets at the riskless (gross) world real interest rate r, which is denominated in terms of the single consumption good.

B. Aggregate Supply

The representative agent supplies labor inelastically so that net aggregate output Y is given by

$$Y_t = A_t K_t^{\alpha} \left[1 - \frac{\theta}{2} \left(\frac{I_t^2}{K_t} \right) \right] \tag{1}$$

where K_t is the capital stock at time t, A_t is time-t productivity, and

$$I_t = K_{t+1} - K_t \tag{2}$$

is investment.[6] The I^2/K term in eq. (1) captures adjustment costs in changing the capital stock. For the present, we will assume that the random component of A is entirely country-

[6]Introducing depreciation slightly complicates the empirical specification below, but does not appear to significantly affect our results. To simplify our exposition here, we omit it.

specific; that is, uncorrelated with productivity shocks abroad. Later, we will generalize the model to the case where there is also a global productivity shock.

The representative firm is assumed to choose the path of $\{I_t\}$ to maximize the present discounted value of future profits discounted at the world interest rate.[7] The solution to this problem is well known (see, for example, Abel and Blanchard (1986), Meese (1980), or Shapiro (1986)). Taking a linear approximation to the first-order conditions yields[8]

$$Y_t \cong \alpha_I I_t + \alpha_K K_t + \alpha_A A_t \tag{3}$$

and

$$I_t \cong \beta_1 I_{t-1} + \eta \sum_{s=1}^{\infty} \lambda^s \left(E_t A_{t+s} - E_{t-1} A_{t+s-1}\right) \tag{4}$$

where in eq. (3) $\alpha_I < 0$ (due to costs of adjustment), and α_K, $\alpha_A > 0$. In eq. (4), $0 < \beta_1 < 1$, $0 < \eta$, and $0 < \lambda < 1$; E_t denotes expectations based on time t information. The first term captures the effects on current investment of lagged productivity shocks, and the second term captures the impact of revisions in expectations about the future path of productivity.

C. Consumption

The representative agent chooses her path of consumption $\{C_t\}$ to maximize

$$E_t \sum_{s=0}^{\infty} \beta^s U(C_{t+s}), \qquad U = C - \frac{\phi}{2} C^2 \tag{5}$$

subject to the intertemporal budget constraint

$$F_{t+1} = rF_t + Y_t - C_t \tag{6}$$

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[7]Our empirical specification implicitly assumes that the covariance of the marginal utility of consumption and investment is constant over time, since the country cannot diversify shocks to productivity.

[8]Implicitly we assume the productivity shocks are homoskedastic, and that the variance terms that would appear in the second-order approximation are constant. Abel and Blanchard (1986) show that for reasonable parameter values a first-order approximation yields virtually the same empirical predictions as the more precise, but much more complicated, second-order approximation.

where F_t denotes foreign assets entering period t.[9] For simplicity, we assume $\beta = 1/r$. The quadratic specification of utility in (5) is, of course, the same as Hall's (1978) random walk model of consumption. The solution to the maximization problem embodied in (5) and (6) yields

$$C_t = \frac{r-1}{r}\left[F_t + E_t\sum_{s=0}^{\infty} y_{t+s}/r^s\right] \equiv \bar{y}_t \tag{7}$$

where $y \equiv Y - I$, so that $\frac{r-1}{r}E_t\sum_{s=0}^{\infty} y_{t+s}/r^s$ is permanent net (of investment) income at time t, defined as $\bar{y}_t$.[10]

As in Hall (1978), the ex-post rate of change of consumption depends only on unanticipated movements in permanent income:

$$\Delta C_t = \left(E_t - E_{t-1}\right)\frac{r-1}{r}\left[E_t\sum_{s=0}^{\infty} y_{t+s}/r^s\right] = \bar{y}_t - E_{t-1}\bar{y}_t \tag{8}$$

where $\Delta C_t \equiv C_t - C_{t-1}$.

D. Exogenous Country-Specific Productivity Shocks

It will be assumed that country-specific productivity shocks follow a first-order autoregressive process:

$$A_t = \rho A_{t-1} + \epsilon_t, \qquad 0 \le \rho \le 1, \tag{9}$$

Extending the analysis to higher-order ARMA processes is straightforward.

E. Deriving the Reduced-Form Estimating Equations for the Current Account and Investment

We are now prepared to solve (1) - (9) to derive estimating equations for investment

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[9] In our formulation, consumption and production takes place at the beginning of the period, and interest is paid at the end of the period.

[10] In deriving (7) it is assumed r is constant. In the empirical work below we implicitly assume that the effects of fluctuating real interest rates on consumption are small.

and the current account. For expositional purposes, we will focus in the text on the random walk productivity case where $\rho = 1$, and treat the more general case in Appendix 1. Combining eqs. (4) and (9) (with $\rho = 1$) yields simply

$$\overset{(+)}{I_t = \beta_1} I_{t-1} + \overset{(+)}{\beta_2} \Delta A_t \tag{10}$$

where $\beta_2 \equiv \eta [\lambda/(1-\lambda)] > 0$. Since it will be convenient in our empirical formulation to solve for the change in investment and the current account rather than the level, we will subtract I_{t-1} from both sides of eq. (10) to obtain:

$$\Delta I_t = \overset{(-)}{(\beta_1 - 1)} I_{t-1} + \overset{(+)}{\beta_2} \Delta A_t \tag{11}$$

We now proceed to obtain a similar reduced-form expression for ΔCA as a function of ΔA and lagged endogenous variables. We begin by differencing the accounting identity for the current account to obtain

$$\Delta CA_t = (r-1)\Delta F_t + \Delta Y_t - \Delta I_t - \Delta C_t \tag{12}$$

We then proceed to substitute out for each of the Δ terms on the RHS of eq. (12). $\Delta F_t = CA_{t-1}$, ΔI_t is given by (11), and ΔY_t is easily obtained by substituting eq. (2) into the first difference of eq. (3), and then using (11) to solve out for ΔI_t:

$$\Delta Y_t = \overset{(+)}{\left[\alpha_I(\beta_1 - 1) + \alpha_K\right]} I_{t-1} + \overset{(+)}{(\alpha_I \beta_2 + \alpha_A)} \Delta A_t \tag{13}$$

Solving for ΔC involves slightly more work. We begin with eq. (8) which gives ΔC as a function of innovations to permanent (net) income. Using eqs. (11) and (12) to substitute our for ΔI and ΔY, and eq. (9) (with $\rho = 1$), one obtains (see Appendix 1)

$$\Delta C_t = \overset{(+)}{\left\{ \frac{\beta_2\left[(\alpha_I - 1)(r-1) + \alpha_K\right]}{r - \beta_1} + \alpha_A \right\}} \Delta A_t \tag{14}$$

Since $r-\beta_1$, $\alpha_A > 0$, the coefficient on ΔA on the RHS of (14) is necessarily positive provided that $(\alpha_I - 1) + \alpha_K/(r-1) > 0$; this corresponds to the condition that the adjustment costs to marginal investment do not exceed the present discounted value of the corresponding output gain, which follows from convexity. Since $\alpha_I < 0$, it follows that $\partial \Delta C/\partial \Delta A > \partial \Delta Y/\partial \Delta A > 0$ (by comparing eqs. (13) and (14)).

The intuition behind the result that the coefficient on the country-specific productivity shock ΔA is greater in eq. (14) for consumption than in eq. (13) for output is simple but important. A permanent productivity shock has a greater effect on ΔC than on ΔY because a permanent rise in A induces investment and leads to a higher future capital stock, thereby causing permanent *net* income $\bar{y}_t$ to rise by more than current *gross* income Y_t. Note that if the country were to hold investment constant in response to the shock, then $\bar{y}$ and Y would rise by exactly the same amount. However, since it becomes profitable to raise investment after a positive productivity shock, $\bar{y}$ and hence C must rise by more than Y.

Combining eqs. (11) - (14) yields the estimating equation for the current account:

$$\Delta CA_t = \overset{(+)}{\gamma_1} I_{t-1} + \overset{(-)}{\gamma_2} \Delta A_t + \overset{(+)}{(r-1)} CA_{t-1} \tag{15}$$

where

$\gamma_1 \equiv (\beta_1 - 1)(\alpha_I - 1) + \alpha_K > 0$, and $\gamma_2 \equiv \beta_2\left[(\alpha_I - 1)(1-\beta_1) - \alpha_K\right]/(r-\beta_1) < 0$.

For exactly the same reasons that the coefficient on ΔA is greater in the consumption equation than in the income equation, one can show that the coefficient on ΔA in the current account eq. (15) is greater in absolute value than the corresponding coefficient in the investment eq. (11); that is $|\partial \Delta CA/\partial \Delta A| > \partial \Delta I/\partial \Delta A > 0$.[11] A permanent rise in

[11]To show that $|\gamma_2| > \beta_2$, note that $\left[(\alpha_I - 1)(1-\beta_1) - \alpha_K\right]/(r-\beta_1) < -1$ iff $\left[(\alpha_I - 1)(\beta_1 - 1) - \alpha_K\right] > r - \beta_1$ iff $(\alpha_I - 1)(r-1) + (\alpha_I - 1)(\beta_1 - r) + \alpha_K > r - \beta_1$ iff $(\alpha_I - 1)(r-1) + \alpha_K > (r-\beta_1)\alpha_I$. This final condition holds provided $(\alpha_I - 1)(r-1) + \alpha_K > 0$, which is again the condition that the present discounted value of higher output from investment exceeds the adjustment cost.

productivity not only worsens the current account due to higher investment, but also, as we have already discussed, because it causes consumption to rise by more than gross output.[12]

Until now we have been analyzing the case of a *permanent* country-specific productivity shock. At the opposite extreme is the case of a purely transitory shock (so that $\rho = 0$ in eq. (9)). In this case there is no effect on investment, and the country runs a current account surplus; in the permanent income model of consumption, agents save part of any transitory increase in income.

The general conditions under which an idiosyncratic country-specific productivity shock will produce a negative innovation in the current account that exceeds the positive innovation in investment in absolute value are now clear. $|\partial \Delta CA / \partial \Delta \epsilon| > \partial \Delta I / \partial \Delta \epsilon$ as long as ρ is sufficiently close to one that $\partial \bar{y} / \partial \epsilon > \partial y / \partial \epsilon$, i.e., so that the innovation to productivity ϵ produces a greater shock to permanent income than to current income. One can readily confirm this intuition by subtracting time t-1 expectations from the current account identity:

$$\left(E_t - E_{t-1}\right) CA_t = \left(E_t - E_{t-1}\right)(Y_t - I_t - C_t) = \left(E_t - E_{t-1}\right)(y_t - C_t) \tag{16}$$

For example, with the autoregressive coefficient on productivity shocks $\rho < 1$, one can derive (see Appendix 1)

$$\left(E_t - E_{t-1}\right) y_t = \left[\left(\alpha_I - 1\right)\beta_2' + \alpha_A\right]\left(A_t - \rho A_{t-1}\right) \tag{17}$$

where $\beta_2' \equiv \eta\lambda\rho / (1 - \lambda\rho)$, and

[12]Note also that the coefficient (γ_1) on I_{t-1} in the ΔCA equation (15) is positive and larger in absolute value than the corresponding coefficient in the ΔI equation $(1 - \beta_1)$. (Note that $\alpha_I < 0$ and $0 < \beta_1 < 1$.) A positive level of I_{t-1} causes the current account to improve both because I_t tends to revert to equilibrium, and also because high lagged investment raises current output. The change in consumption ΔC_t is, of course, unaffected by any variables dated t-1 or earlier, including lagged investment.

$$\left(E_t - E_{t-1}\right)C_t = \left\{ \frac{\beta_2'(r-1)\left[(\alpha_I - 1)(r-1)\right] + \alpha_K}{(r-\beta_1)(r-\rho)} + \frac{\alpha_A(r-1)}{r-\rho} \right\} \left(A_t - \rho A_{t-1}\right) \tag{18}$$

$$= C_t - C_{t-1}$$

It is straightforward to check that for ρ small enough, the productivity shock $(A_t - A_{t-1})$ will cause a smaller unanticipated increase in consumption than in income, so that the unanticipated change in the current account will be smaller than the unanticipated change in investment.

In the preceding analysis we have assumed that the productivity shocks are entirely country-specific and that there are no government spending shocks. We turn to these two issues next.

F. Global productivity shocks

Suppose that the productivity shock A contains in addition to a country-specific component A^c, a global shock component (common to all countries) A^w, so that eq. (1) is replaced by

$$Y_t^c = \left(A_t^w + A_t^c\right) K_t^\alpha \left[1 - \frac{\theta}{2} \left(\frac{I_t^2}{K_t} \right) \right] \tag{19}$$

for country c. If all countries have identical preferences, technology and initial capital stocks, then the change in a country's current account depends on its country-specific shock A^c, but not on the global shock A^w since the latter impacts on all countries equally.[13] World interest rates rise to bring global savings and investment into equilibrium.

A^w does, of course, affect investment, but by less than an idiosyncratic shock of the

[13]This assumes zero initial net foreign asset positions, which is a reasonable empirical approximation.

same duration, since A^w affects world interest rates. Equation (12) is then replaced by

$$\Delta I_t = (\beta_1 - 1)I_{t-1} + \beta_2 \Delta A_t^c + \beta_3 \Delta A_t^w \tag{20}$$

where, if both A^w and A^c follow random walks ($\rho = 1$)), $0 < \beta_3 < \beta_2$ due to the interest rate effect of the global shock.[14] If, however, the global shock is permanent and the country-specific shock is sufficiently transitory, then, of course, β_3 may be greater than β_2.

G. Government spending shocks

Introducing country-specific government (consumption) spending shocks is similarly straightforward. We assume that government spending is purely dissipative (or equivalently that utility is separable in private and public consumption), and is financed by exogenous lump-sum taxes. In this case, country-specific government spending shocks G^c should have no effect on I, though global government spending shocks G^w can have an impact though the real interest rate.[15] The reverse is true for the current account. Global shocks should not impact on the current account but country-specific government spending shocks may if they are temporary. (A permanent rise in G^c will be fully offset by a permanent fall in C.)

Defining permanent country-specific government spending as $\bar{G}_t^c \equiv [(r-1)/r]E_t \sum_{s=0}^{\infty} G_{t+s}^c / r^s$, the current account eq. (15) becomes[16]

$$\Delta CA_t = \gamma_1 I_{t-1} + \gamma_2 \Delta A_t^c + \left(\bar{G}_t^c - E_{t-1}\bar{G}_t^c - \Delta G_t^c\right) + (r-1)CA_{t-1} \tag{21}$$

A temporary rise in country-specific government spending G^c leads to a deterioration in the current account since permanent after-tax income declines by less than the rise in G^c.

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[14]Since β_3 arises out of the standard closed-economy model, we do not present an explicit derivation here; see Abel and Blanchard (1986) or Blanchard and Fischer (1989) for further discussion.

[15]Note that global government spending shocks will only affect I if they are transitory; permanent G^w shocks have no effect because they do not affect the real interest rate. See Barro (1986). A positive temporary shock to G^w should tend to lower I, since it raises interest rates.

[16]See Ahmed (1986) for a closely related specification of the effect of G shocks on the current account.

Suppose, for example, that G^c is governed by the IMA (0,1,1) process:

$$G_t^c = G_{t-1}^c + \epsilon_{Gt} - \theta\epsilon_{Gt-1} \tag{22}$$

Then one can show that in eq. (21), the term $\bar{G}_t^c - E_{t-1}\bar{G}_t^c - \Delta G_t^c$ equals $\theta\left(\epsilon_{Gt-1} - \epsilon_{Gt}/r\right)$.

H. Error Specification

As a final step before our empirical estimation, we introduce additive error terms μ_{It}, μ_{Yt}, and μ_{Ct} to the investment, output and consumption eqs. (4), (3) and (7). The μs are assumed independent of each other (although this assumption is not necessary for identification of the key parameters of interest). The error terms in eqs. (11) and (13) for ΔI and ΔY become μ_{It} and $\alpha_I\mu_{It} + \Delta\mu_{Yt}$, respectively. The error term for the ΔC equation becomes

$$\left[\frac{(\alpha_I - 1)(r-1) + \alpha_k}{r - \beta_1}\right]\mu_{It} + \frac{r-1}{r}\mu_{Yt} + \Delta\mu_{Ct} \tag{23}$$

and the error term in the ΔCA equation (15) becomes

$$\frac{(\alpha_I - 1)(1 - \beta_1) + \alpha_K}{r - \beta_1}\mu_{It} + \Delta\mu_{Yt} - (r-1)\mu_{Yt}/r - \Delta\mu_{Ct} \tag{24}$$

With this error specification, we see that I_{t-1} may be treated as a predetermined variable in the regression for ΔCA_t, but CA_{t-1} is endogenous.

III. Empirical Results for Productivity, the Current Account and Investment

Before turning to look at the effects of productivity shocks on the current account and investment using eqs. (15) and (20), it is useful to look at some simple correlations between investment and the current account. One small branch of the Feldstein-Horioka literature looks at current account-investment correlations, arguing that a high negative correlation would be evidence of open capital markets.

Sachs (1981, 1983) argues that there is indeed a high negative correlation between current accounts and investment in cross-country long-term average data for OECD countries. Penati and Dooley (1984), however, find that Sachs' results are very sensitive to the selection of countries in the sample. When a few outliers are excluded, the correlation disappears; Tesar (1991) confirms this sensitivity. Roubini (1990), however, finds that when one augments nonstructural current account-investment equations with government budget deficits, a negative current account-investment correlation arises in time-series data.

Of course, as we have seen in the preceding theoretical discussion, the simple correlation between current accounts and investment does not provide any evidence whatsoever on the degree of capital market integration, even if one assumes that the correlation is entirely driven by productivity shocks. If the shocks are permanent and country-specific, the correlation will indeed be negative. But if there is a substantial global component to the productivity shocks, and if the country-specific component is sufficiently temporary, the correlation may easily be positive.

A. Reduced-form regressions for ΔCA on ΔI

With the above caveat, we proceed to look at some time-series properties of the current account and investment. In Table 1 below, we regress the change in the (real) current account ΔCA on a constant and the change in (real) investment ΔI using 1961-1990 annual data for eight industrialized countries. The construction of all variables is described in Appendix 2.[17] Interestingly, we find that when one looks at time series data, there is

[17]The eight countries include the G-7 plus the Netherlands. The countries in our sample were based on the availability of BLS data for productivity; we excluded Scandinavian countries where more than fifty percent of total investment is typically government investment. GDP or GNP deflators are used to construct real variables.

indeed a fairly robust (negative) correlation between changes in the current account and investment. The individual-country coefficients on ΔI range from -.16 to -.55, averaging -.33. That is, on average only a third of any change in domestic investment is funded by foreign capital flows. All coefficients are significant at better than the .02 marginal significance level (reported in parentheses), with the exception of the Netherlands. In the lower half of the table, we look at the remaining OECD countries. Again, the negative correlation is quite significant, with the point estimates being slightly larger on average. In Table 1a, we look at the sub-periods 1961-74, and 1975-90 for the eight-country sample. As the table indicates, the negative correlation between ΔCA and ΔI is also generally stable across the sub-periods, rising slightly in the second half of the sample. Again, there is no way to say whether a coefficient of -.33 is large or small with open capital markets without information on the sources and time series characteristics of the underlying disturbances.

B. Construction and time-series properties of A^c and A^w

Any attempt to give structural interpretation to the current account-investment relations in terms of productivity shocks requires some information on the time-series properties of productivity, A, and on its decomposition into temporary and permanent and into country-specific and global components, A^c and A^w. We construct Solow residual productivity measures using data published by the Bureau of Labor Statistics (BLS) on output and employment hours in manufacturing for major industrialized countries, 1960-90 (see Appendix 2). We form the productivity measures as the residuals from Cobb-Douglas production functions:

$$\ln Y - \pi \ln L - (1-\pi)\ln K, \tag{25}$$

where π, the share of labor in manufacturing output, is based on data from the OECD intersectoral data base.[18] Capital, K, which is not measured, is proxied by a trend term. Backus, Kehoe and Kydland (1992) have applied a similar approach, arguing that for the United States, short-term movements in capital are small relative to short-term movements in output. Given the well-known problems in constructing comparable capital stock measures in cross-country data (see, for example, the discussion in Griliches (1988)), the BLS-based Solow residual measure would seem to be a good starting point for testing the model.

We note that estimates of Solow residuals that attempt to control for capital inputs can be obtained from the OECD international sectoral data base (see Appendix 2), but are available only for 1970-85. Since our model emphasizes dynamic issues, we were reluctant to use these as our main measure. In any event, we will later demonstrate that results based on the OECD total factor productivity residuals over the shorter time period are very similar to the results one obtains with the BLS-based residuals over the full sample. This is not surprising given that the two measures appear very highly correlated; see Figure 1 which graphs the two measures for the overlapping sample period. We will also discuss results based on straight output/worker hour.

The main justification for our focus on manufacturing sector productivity is that far more accurate cross-country data is available for manufacturing than for services, particularly over the earlier part of the sample. Productivity in services is notoriously difficult to measure, and international comparisons are further complicated by the high variability in the relative price of non-traded goods across countries.

Our world productivity measure is formed by taking a GNP-weighted average of the

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[18]See Meyer-zu-Schlochtern (1988) and Englander and Mittelstädt (1988). The estimates for π used are labor share in the traded goods sector: United States, .64; Japan, .62; Germany, .61; France, .68; Italy, .49; U.K., .59; Canada, .63; and are taken from Stockman and Tesar (1990). The labor share for Netherlands was assumed to be the same as that of Germany.

eight individual-country measures,[19] and the country-specific component is then formed as the deviation from the global average.[20] Table 2 presents Dickey Fuller unit root tests (with a constant and trend) for our productivity measures for the eight countries in the sample, and for the world average. In none of the cases is one able to reject the unit root hypothesis at standard significance levels.[21] The third column of the table presents estimates for a first-order autoregressive process. As one can see, the estimates of ρ are all very close to one.

Whether or not the *A*s are literally random walks, or just damp very slowly, is not central to the empirical tests below. For example, the hypothesis that the coefficient on ΔA^c should be larger in the ΔCA equation than the corresponding coefficient in the ΔI equation does not exhibit knife-edged instability with respect to the assumption $\rho = 1$. Since the random walk assumption does not appear to be a bad approximation, we will simply impose it in the remainder for both A^c and A^w. There does appear to be some residual positive serial correlation in a couple of the series even after taking first differences, particularly in ΔA^w. We will discuss the significance of this residual correlation in ΔA^w later below.[22]

C. Structural Estimates of the ΔCA and ΔI equations

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[19]The weights were constructed from each "foreign" country's share of total GDP in 1975, where local currency GDP figures were converted to dollars by the average dollar exchange rate for the year.

[20]We also considered a more elaborate approach to decomposing A into A^c and A^w. We regressed A for each country on a GNP-weighted average of A (A^f) for the other seven countries, treating the residual as the country-specific component. We found in all cases that one could not reject the hypothesis that both A and A^f have unit roots, and that they are not cointegrated. The more elaborate procedure gives very similar results in our current account and investment equations. The two approaches to decomposing A become equivalent as the number of countries becomes large.

[21]We also tested the unit root hypothesis against the alternative of a deterministic trend with a break, based on the procedure proposed by Christiano (1992), which does not impose priors on the point in time where the break occurs. One cannot reject the hypothesis of a unit root in favor of a trend break for any of the countries at the 10 percent level of significance. For a version of the test corresponding to an augmented Dickey-Fuller regression, one can reject the unit root null at the 5 percent level for Italy and 7 percent for the U.K.

[22]Estimating a first-order MA process in ΔA^w yields a point estimate of .52, with a standard error of .16. There also appears to be some positive serial correlation in ΔA^c for France, Germany, and the U.K., though less than for ΔA^w.

We are now prepared to estimate the central structural equations of our model, eqs. (15) and (20) for ΔCA and ΔI. Table 3 present individual country results under the assumption $\rho = 1$.[23]

For ΔI, the coefficients on ΔA^c and ΔA^w are of the correct sign in virtually all cases, and are significant in more than 70 percent of the cases. The Ljung-Box Q-statistic does indicate serial correlation for Germany and the U.K. In Table 3a we report results based on conditional heteroskedasticity and autocorrelation-consistent standard errors; the results are quite similar.[24] The fact that the coefficients on ΔA^w are typically larger than for ΔA^c in the investment equation might be attributable to the positive serial correlation in the first difference of the world productivity shocks. The coefficients on the lagged investment level, I_{t-1}, are generally not significant.

Table 3 also presents results for the ΔCA equation. To deal with possible simultaneity of CA_{t-1} in (20), we constrain its coefficient to equal its theoretically-predicted value $r - 1$.[25] Given the near random walk behavior of the country-specific productivity shocks, one would expect the estimated coefficients on ΔA^c to be negative, as indeed they are in all cases except for the Netherlands. Four cases are significant. (Again, results reported in Table 3a based on conditional heteroskedasticity and autocorrelation-consistent standard

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[23]The results are not sensitive to the inclusion of time trends in the ΔCA regressions, but we excluded them on *a priori* grounds. The ΔI results are only marginally worse without trends, though the results for the U.S. are actually markedly better. To facilitate the cross-country comparison of the coefficients on productivity and trend terms, for each country these variables were multiplied by the mean of local real GDP or GNP over the sample period. This gives the reported coefficients on ΔA^c and ΔA^w the interpretation of the change in the lefthand side variable *as a percent of mean GNP* in response to a 1 percent increase in productivity.

[24]These results are obtained using the ROBUSTERRORS option to the LINREG command in RATS, with DAMP=1 and $L=2$. This provides Newey-West estimates of the covariance matrix corrected for heteroskedasticity and for serial correlation in the form of a moving average of order 2.

[25]As our proxy for r, we use the real world interest rate series constructed by Barro and Salai-Martin (1990). Fluctuations in $(r-1)CA_{t-1}$ are quite small relative to fluctuations in ΔCA_t.

errors are quite similar.) The model also predicts that world productivity shocks, ΔA^w, should have no effect on current accounts since they affect all countries equally. This hypothesis cannot be rejected for any country. It should be noted that the eight countries included in our proxy for world productivity shocks, while constituting a significant share of world output, provide somewhat less than complete world coverage. With less than 100 percent of the world represented, one would still expect that the coefficient on ΔA^w to be much smaller than on ΔA^c.

Table 4 reports results for the full pooled time-series cross-section data set, with and without country-specific time trends.[26] As in the individual country regressions, the coefficients in the ΔI equations are of the correct sign, and all are highly significant. ΔA^c is negative in the pooled ΔCA regressions, and is highly significant. The point estimates for the world shock ΔA^w remain small in the pooled ΔCA equations, and are insignificantly different from zero.

The main puzzle in Tables 3 and 4 lies in the relative magnitudes of the coefficients on ΔA^c in the ΔI and ΔCA equations. Both in Table 4, and in the individual country results in Table 3, the coefficient on ΔA^c is *smaller* in absolute value in the current account regressions than in the ΔI regressions. For the pooled results, it is less than half as large. Given the evidence in Table 2 that productivity shocks follow near random walks, one would expect the current account response to be *larger* than the investment response, since

[26]The pooled results are estimated using the SUR command in RATS, a GLS system procedure, with equality restrictions imposed across equations, excluding the constants and time trends. To adjust for cross-country heteroskedasticity and allow the pooling of data in different currency units, we scaled all variables in each equation in the system by the standard error of the corresponding OLS country regression. In addition, as in the individual country OLS regressions, variables without units, such as productivity changes and trend terms, were multiplied by the mean of local real GNP or GDP over the sample period. We used the SUR option ITER which begins with estimates of cross-country covariances based on the residuals from individual country OLS regressions and recomputes the covariances and system equation estimates iteratively. We set a maximum of 25 iterations, but all results converged before reaching this limit.

consumption should move by more than output. Similarly, the coefficient on I_{t-1} in the ΔCA equation in Table 4, though of the correct sign, is smaller rather than larger (in absolute value) than the corresponding coefficient in the ΔI equation. Table 4 also reports pooled results for the ΔC equation (18) and the ΔY equation (13). The higher values of the ΔA^c coefficient in the output equation is consistent with the explanation that the ΔA^c anomaly is at least partly due to a sluggish consumption response. An alternative explanation would be that our specification omits government spending shocks and this is the issue we turn to next.

D. Temporary government spending shocks

Recall that in theory, permanent country-specific government spending shocks have no effect on investment, whereas global government spending shocks have no effect on current accounts. G^c shocks can affect ΔCA, and G^w shocks can affect ΔI, but in each case only if they are temporary.[27]

To estimate temporary shocks to government spending, we estimate the ARIMA (0,1,1) process given in eq. (22) above, again forming G^w as a weighted average of individual-country Gs, normalized by GNP.[28] Given our assumption that ΔG follows on MA(1) process, $\left(\bar{G}_t^c - E_{t-1}\bar{G}_t^c - \Delta G_t^c\right)$ is then given by the formula below eq. (22), $\theta^c\left(\epsilon_{Gt-1}^c - \epsilon_{Gt}^c/r\right)$. $\bar{G}_t^w - E_{t-1}\bar{G}_t^w$, the temporary component of changes in G^w, is given by $(r-\theta^w)\epsilon_{Gt}^w/r$. The pooled time series cross-section results are presented in Table 5, where G is measured by real government consumption (see Appendix 2).[29] The coefficients on ΔA^c,

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[27]Permanent G^c shocks are offset by permanent changes in domestic consumption. Similarly, permanent changes in G^w do not cause any tilt in world interest rates.

[28]To form G^w, we normalized each country's G by the country's average level of GNP in the period, and then formed a world index using 1975 nominal GNP weights.

[29]We measured the r in the G shock formulas by the mean over the period of the world real interest rate constructed by Barro and Sala-i-Martin (1990).

ΔA^w, and I_{t-1} remain exactly as before, and the G shocks do not enter significantly. Individual country regressions are also largely unaffected by the inclusion of G shocks.[30] The fact that government spending appears to have relatively little impact may be due to the difficulty of extracting the temporary component of changes in G.

E. Alternative Empirical Measures of Productivity

In addition to our BLS-based Solow residual estimates, we tried two alternative measures of productivity. The first was straight output/worker hour, without attempting to adjust for decreasing returns to labor inputs as in (25). The results are qualitatively extremely similar to those presented above, both for the time series of productivity and for Tables 3 and 4.

Next, we used data on total factor productivity in manufacturing from the OECD international sectoral data base, available for the years 1970-1985. These estimates attempt to account for changes in capital. Table 6 presents pooled results corresponding to those in Table 4 for the BLS-based Solow residual estimates. The results are extremely similar to those in Table 4, except that the coefficients on both local and global productivity are somewhat larger in Table 6.[31] The coefficient on ΔA^w is actually significant in the ΔCA regression with a time trend, but it is much smaller in magnitude than the coefficient on the country-specific shock, ΔA^c. As mentioned above, one possible rationale why ΔA^w might

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[30]To check the robustness of these results, we also entered ΔG and ΔG^w in raw form into the ΔCA and ΔI equations, respectively, but they remain insignificant. We also tried controlling for world interest rates directly in the ΔCA and ΔI equations using the Barro and Sala-i-Martin (1990) measure of world real interest rates; again the productivity coefficients were little affected.

[31]We also estimated the regressions in Table 6 using business sector total factor productivity despite the misgivings expressed above. For the ΔI equation with a time trend we obtained estimates of 1.08 for b_1 and .64 for b_2 with marginal significance levels of .00 in both cases. For the ΔCA equation without a time trend, we obtained estimates of -.08 for b_1 and -.04 for b_2 with marginal significance levels of .04 and .44, respectively.

enter significantly with a very small coefficient is that the eight industrialized countries here do not quite constitute 100 percent of world GNP, even among countries with relatively open capital markets. The individual-country results are also qualitatively similar, with only slightly fewer coefficients significant at the 5 percent level, due in part to the shorter sample.

Note that the coefficients on ΔA^c in the ΔCA and ΔI equations are actually much closer in magnitude in Table 6 than in Table 4, though they are tightly estimated and remain smaller in the ΔCA equations. As a final check, we present in Table 7 pooled estimates using the BLS-based Solow residuals for the post oil-shock period. Overall, the results are similar to the OECD-based results for the recent period in Table 6.

F. Productivity shocks as explanation for nonstructural ΔCA-ΔI correlations

Although the nonstructural current account/investment correlations presented in Table 1 are not the focus of our analysis, it is nevertheless interesting to see whether our structural model can generate these simple correlations. Since our point estimates in Tables 3 and 4 suggest fairly rapid adjustment in investment ($\beta_1 = .85$ in the pooled data), we will make the simplifying approximation that $\beta_1 = 1$.[32] Then, using equations (15) and (20), one can easily solve for the slope coefficient b in the regression of ΔCA on ΔI as

$$b = \frac{\gamma_2}{\beta_2}\left[\frac{\sigma^2_{\Delta A^c}}{\sigma^2_{\Delta A^c} + \sigma^2_{\Delta A^w}}\right] \tag{26}$$

where in arriving at (26), we have also used the further simplifying assumption (in line with our estimates) that $\beta_2 = \beta_3$.[33]

To implement (26), note that the pooled results in Table 4 provide an estimate of

[32]Using our point estimates of β_1 would not drastically change the calculation below.

[33]We have also assumed that ΔA^c is uncorrelated with ΔA^w, which holds exactly for a small country.

γ_2/β_2 roughly equal to .45. The ratio $\sigma^2_{\Delta A^c}/\left(\sigma^2_{\Delta A^c}+\sigma^2_{\Delta A^w}\right)$ is .49 in our sample when averaged over the eight countries.[34] Combining these two parameters, one obtains an estimate of b=.22 which is not far from .33, the average coefficient in the upper half of Table 1.

This calculation is only suggestive, yet nevertheless indicates how our model based on productivity shocks might substantially account for the observed reduced-form correlations between ΔCA and ΔI. Roughly half the reason the simple regression coefficient is below 1 is that global shocks are of roughly equal magnitude to country-specific shocks for the eight countries. The other half of the explanation is that consumption under-responds to country-specific shocks.

V. Conclusions

Overall, we find that a linear quadratic intertemporal model with costs of adjustment in investment performs fairly well in explaining current account and investment changes in 1961-1990 annual data for major industrialized countries. Both country-specific and global productivity shocks enter with the theoretically predicted sign (often significantly) in the preponderance of cases, and are strongly significant in the pooled cross-section time-series regressions (except, of course, that global productivity does not significantly affect current accounts). These results lend support to the view that the intertemporal approach to the current account, indeed, has some practical merit.

Nevertheless, it is still a puzzle in the data that country-specific shocks to productivity appear to affect the current account by significantly less than they affect investment, despite

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[34]The ratio $\sigma^2_{\Delta A^c}/\left(\sigma^2_{\Delta A^c}+\sigma^2_{\Delta A^w}\right)$ is as follows for the countries in our sample: U.S., .32, Canada, .56; Japan, .70; France, .42; Germany, .37; Italy, .63; Netherlands, .50; U.K., .41.

the fact that the shocks appear to damp relatively slowly. One possible explanation is that country-specific risk is at least partially diversified away in international capital markets, so that consumption rises by less than output even in the face of a permanent country-specific productivity shock. However, the fact that country-specific shocks have significant effects on the current account generally in line with our model suggests that it may provide a better approximation to reality than models that assume complete insurance.

An alternative explanation for the current account under-response puzzle is that capital markets are in fact open, but not as open as our frictionless model would suggest. There may, for example, be a moral hazard in investment at a microeconomic level,[35] which forces domestic residents to self-finance a greater proportion of investment than would be the case in a frictionless model. Finally, the under-response puzzle may be partly attributable to the presence of nontraded goods or factors; it should be possible to extend the approach developed here to incorporate nontradeables.[36]

[35]See, for example, Gertler and Rogoff (1990).

[36]Stockman and Tesar (1990) present a real business cycle model with nontraded goods, though their focus is on other issues; see also the discussion in Baxter and Crucini (1992). Our result that current accounts respond by less than investment to permanent idiosyncratic productivity shocks bears some relation to Deaton's (1987) finding that consumption under-responds to changes in the growth rate of income in a closed economy model, though our central hypothesis does not revolve critically around whether there is a unit root in productivity. Also, with our open-economy data, we are able to make the issue more precise by separating out global from country-specific shocks.

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Appendix 1 *Derivation of equations (14) and (18) for* ΔC

From eq. (8),

$$\Delta C_t = \bar{y}_t - E_{t-1}\bar{y}_t, \text{ where } \bar{y}_t = \left(\frac{r-1}{r}\right) E_t \sum_{s=0}^{\infty} y_{t+s}/r^s .$$

Denoting the revision of expectations operator $E_t - E_{t-1}$ as "$\sim$", eq. (13) implies that ΔC_t can be expressed as a proportional function (by the constant $(r\text{-}1)/r$) of the following expression:

$$\sum_{s=0}^{\infty} \tilde{y}_{t+s}/r^s \equiv \sum_{s=0}^{\infty} \left(\tilde{Y}_{t+s} - \tilde{I}_{t+s}\right)/r^s = \sum_{s=0}^{\infty} \left[(\alpha_I - 1)\tilde{I}_{t+s} + \alpha_A \tilde{A}_{t+s} + \alpha_K \tilde{K}_{t+s}\right]/r^s \tag{A1}$$

When $\rho = 1$, note that by eqs. (9) and (10)

$$\tilde{A}_{t+s} = \Delta A_t, \qquad \forall s \tag{A2}$$

and

$$\tilde{I}_{t+s} = \beta_2 \beta_1^s \Delta A_t, \qquad \forall s \tag{A3}$$

By eqs. (2), (A2), and (A3),

$$\tilde{K}_{t+s} = \sum_{i=0}^{s} \tilde{I}_{t+i-1} = (\beta_2/\beta_1)\Delta A_t \left[\left(\sum_{i=0}^{s} \beta_1^i\right) - 1\right] \tag{A4}$$

Eqs. (A2) - (A4) imply

$$\sum_{s=0}^{\infty} \tilde{A}_{t+s}/r^s = \frac{r}{r-1}\Delta A_t \tag{A5}$$

$$\sum_{s=0}^{\infty} \tilde{I}_{t+s}/r^s = \beta_2 \left(\frac{r}{r-\beta_1}\right)\Delta A_t \tag{A6}$$

$$\sum_{s=0}^{\infty} \tilde{K}_{t+s}/r^s = \sum_{s=0}^{\infty}\sum_{i=0}^{s} \tilde{I}_{t+i-1}/r^s = \beta_2 \left(\frac{r}{r-\beta_1}\right)\left(\frac{1}{r-1}\right)\Delta A_t \tag{A7}$$

Substituting (A5) - (A7) into (A1) gives the reduced-form expression (14) for ΔC_t.

When $\rho < 1$, eqs. (4) and (9) imply

$$\begin{aligned} I_t &= \beta_1 I_{t-1} + \eta \sum_{i=1}^{\infty} (\lambda\rho)^i \Delta A_t \\ &= \beta_1 I_{t-1} + \beta_2' \Delta A_t \end{aligned} \tag{A8}$$

where $\beta_2' = \eta\lambda\rho / (1 - \lambda\rho)$.

It follows from (9) and (A8) that

$$\tilde{A}_{t+s} = \rho^s A_t, \qquad \forall s \tag{A9}$$

and

$$\tilde{I}_{t+s} = \beta_2' \sum_{j=0}^{s} \beta_1^j \Delta\tilde{A}_{t+s-j}, \qquad \forall s \tag{A10}$$

where again by (9)

$$\Delta\tilde{A}_{t+s} = \begin{cases} \epsilon_t & \text{for } s = 0 \\ \rho^{s-1}(\rho - 1)\epsilon_t & \text{for } s \geq 1 \end{cases} \tag{A11}$$

By eqs. (2), (A10) and (A11)

$$\tilde{K}_{t+s} = \sum_{i=0}^{s} \tilde{I}_{t+i-1} = \beta_2' \sum_{i=0}^{s} \sum_{j=0}^{i} \beta_1^j \Delta\tilde{A}_{t+i-1-j} \tag{A12}$$

Eqs. (A9) - (A12) imply

$$\sum_{s=0}^{\infty} \tilde{A}_{t+s} / r^s = \sum_{s=0}^{\infty} \rho^s \epsilon_t / r^s = \frac{r}{r - \rho} \epsilon_t \tag{A13}$$

$$\sum_{s=0}^{\infty} \tilde{I}_{t+s} / r^s = \beta_2' \sum_{s=0}^{\infty} \sum_{j=0}^{s} \beta_1^j \Delta\tilde{A}_{t+s-j} / r^s = \beta_2' \left[\frac{r}{r - \beta_1} \right] \left[1 + \frac{\rho - 1}{r - \rho} \right] \epsilon_t \tag{A14}$$

$$\sum_{s=0}^{\infty} \tilde{K}_{t+s} / r^s = \beta_2' \sum_{s=0}^{\infty} \sum_{i=0}^{s} \sum_{j=0}^{i} \beta_1^j \Delta\tilde{A}_{t+i-1-j} / r^s = \beta_2' \left[\frac{r}{r - \beta_1} \right] \left[\frac{1}{r - 1} \right] \left[1 + \frac{\rho - 1}{r - \rho} \right] \epsilon_t \tag{A15}$$

Substituting (A13) - (A15) into (A1) gives the reduced-form expression (18) for ΔC_t.

Appendix 2 *Data*

Annual data for the years 1960-1990 for the current accounts of the balance of payments were obtained from International Financial Statistics (IFS), line 77a.d. Because the current accounts were expressed in dollars, they were converted to local currencies using the average market exchange rates for the year (rf). Data on France's current account is available only from 1967, because of the absence of data on the transactions between metropolitan France and countries in the franc area in prior years.

Annual data on nominal investment, output, consumption, and government spending were obtained from the national accounts section of the IFS for each country. Investment was defined as the sum of gross fixed capital formation (line 93e) and changes in (inventory) stocks (line 93i). For the United States the investment total included government gross fixed capital formation (line 93 gf). Consumption was defined as private consumption (line 96f). Government spending was defined as government consumption (line 91f, or 91ff less 93gf in the case of the U.S.). Output was defined as GDP (line 99b) or when not available by GNP (line 99a).

All nominal aggregates were converted into real terms by the GDP or, where necessary, by the GNP deflator. The deflator was calculated as the ratio of real GDP (line 99b.r or 99b.p) or GNP (99a.r) to the corresponding nominal output aggregate.

To construct productivity, we used Bureau of Labor Statistics figures on manufacturing output and employment hours, as reported in "International Comparisons of Manufacturing Productivity and Unit Labor Costs, 1990," Table 2 (BLS, U.S. Department of Labor, 91-406). The BLS reports these figures only for twelve industrial countries. Denmark, Norway, and Sweden were excluded from the study because of the extent of the role of the public sector in investment, and Belgium was not available for the complete sample. We formed our basic measure of total factor productivity as the Solow residuals from Cobb Douglas production functions, according to eq. (25) in the text, using the BLS data on manufacturing output and hours and the labor share figures of Stockman and Tesar (1990), and treating capital as following a constant trend.

An alternative measure of total factor productivity in manufacturing for the years 1970-1985 controlling for capital inputs was constructed using data on output, employment, and the capital stock from the OECD international sectoral data base and the Stockman and Tesar labor share figures.

Table 1
Time-Series Regressions of
Current Account on Investment
$$\Delta CA_t = a + b\Delta I_t$$

Country	Sample Period	b	R^2	D.W.
U.S.	1961-90	-0.16 (.02)	.18	1.44
Japan	1961-90	-0.32 (.00)	.40	1.27
Germany	1961-90	-0.29 (.01)	.21	1.94
France	1968-90	-0.37 (.00)	.34	1.82
Italy	1961-90	-0.55 (.00)	.61	1.95
U.K.	1961-90	-0.53 (.00)	.53	2.08
Canada	1961-90	-0.31 (.00)	.37	2.06
Netherlands	1961-90	-0.24 (.17)	.07	1.96
Austria	1965-90	-0.35 (.00)	.32	2.10
Belgium	1962-90	-0.06 (.62)	.01	1.62
Denmark	1961-90	-0.51 (.00)	.44	1.54
Finland	1961-90	-0.48 (.00)	.66	2.27
Greece	1961-90	-0.15 (.00)	.94	2.20
Iceland	1961-90	-0.95 (.00)	.69	2.36
Ireland	1961-90	-0.71 (.00)	.43	1.84
Norway	1961-90	-1.13 (.00)	.79	2.30
Portugal	1973-90	-0.65 (.01)	.33	1.71
Spain	1961-90	-0.67 (.00)	.62	1.61
Sweden	1961-90	-0.42 (.00)	.31	2.13
Switzerland	1961-90	-0.51 (.00)	.29	1.90
Turkey	1961-89	-0.15 (.34)	.03	2.23
Australia	1962-90	-0.47 (.00)	.44	2.10
New Zealand	1968-89	-0.74 (.00)	.64	2.57

Note: Figures in parentheses are marginal significance levels; i.e., probability of Type I error.

Table 1a
Time-Series Regressions of
Current Account on Investment (Sub-Samples)

$$\Delta CA_t = a + b\Delta I_t$$

Country	Sample Period	b	R^2	D.W.
U.S.	1961-74	0.04 (.68)	.01	2.67
Japan	1961-74	-0.21 (.07)	.24	.89
Germany	1961-74	-0.35 (.00)	.58	2.22
France	1961-74	0.10 (.85)	.01	1.74
Italy	1961-74	-0.50 (.01)	.44	2.54
U.K.	1961-74	-0.37 (.09)	.22	1.39
Canada	1961-74	-0.40 (.00)	.52	3.04
Netherlands	1961-74	-0.43 (.07)	.25	1.44
U.S.	1975-90	-0.20 (.04)	.27	1.18
Japan	1975-90	-0.37 (.00)	.49	1.54
Germany	1975-90	-0.23 (.24)	.10	1.60
France	1975-90	-0.42 (.00)	.47	1.42
Italy	1975-90	-0.59 (.00)	.71	1.19
U.K.	1975-90	-0.60 (.00)	.72	1.81
Canada	1975-90	-0.30 (.01)	.38	1.88
Netherlands	1975-90	-0.18 (.50)	.03	1.97

Note: Figures in parentheses are marginal significance levels, i.e., probability of Type I error.

Table 2

Country-Specific and Global Productivity Unit Root Tests, 1961-90

Country	DF t_τ	ADF t_τ	$\hat{\rho}$ [S.E.]
U.S.	-0.37	-0.77	.93 [.026]
Japan	-1.18	-0.89	.94 [.020]
Germany	-1.13	-1.67	.98 [.075]
France	-0.56	-0.88	.91 [.049]
Italy	-1.80	-1.63	.95 [.042]
U.K.	-1.19	-1.45	.90 [.030]
Canada	-2.55	-1.90	1.01 [.079]
Netherlands	-0.61	-0.72	.96 [.037]
Global	-2.01	-2.31	.97 [.012]

Note: DF t_τ is the t-statistic on b_1 in the regression $\Delta A_t = \alpha + b_1 A_{t-1} + b_2 T$. ADF t_τ is the t-statistic on b_1 in the augmented regression $\Delta A_t = \alpha + b_1 A_{t-1} + b_2 T + b_3 \Delta A_{t-1}$. Critical values for t_τ (with 25 observations) are -3.60 at 5 percent and -3.24 at 10 percent. $\hat{\rho}$ is the coefficient on A_{t-1} in the regression $A_t = \alpha + \rho A_{t-1}$ with the *standard error* in parentheses.

Table 3

Individual Country Time-Series Regressions, 1961-90

$$\Delta Z_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T$$

Country	ΔZ	b_1	b_2	b_3	$b_4 \times 10^2$	R^2	Q-msl
U.S.	ΔI	.19 (.32)	.41 (.00)	-.22 (.30)	.11 (.29)	.53	.87
	ΔCA	-.13 (.10)	.01 (.89)	.04 (.26)		.12	.27
Japan	ΔI	.42 (.00)	.58 (.00)	.09 (.28)	.06 (.57)	.68	.87
	ΔCA	-.14 (.03)	-.06 (.52)	-.04 (.10)		.19	.40
Germany	ΔI	.46 (.00)	.52 (.00)	-.15 (.27)	.13 (.01)	.55	.00
	ΔCA	-.21 (.10)	.01 (.95)	.02 (.84)		.12	.15
France	ΔI	.45 (.02)	.44 (.01)	-.14 (.20)	.14 (.04)	.36	.53
	ΔCA*	-.07 (.66)	.03 (.87)	.01 (.90)		.03	.16
Italy	ΔI	.60 (.00)	.27 (.16)	-.17 (.25)	.16 (.11)	.65	.16
	ΔCA	-.30 (.01)	-.11 (.54)	-.03 (.58)		.24	.48
U.K.	ΔI	.49 (.00)	.65 (.00)	.05 (.60)	.00 (.86)	.76	.00
	ΔCA	-.46 (.00)	-.20 (.03)	.00 (.94)		.49	.64
Canada	ΔI	.42 (.01)	.16 (.35)	-.12 (.50)	.13 (.33)	.44	.17
	ΔCA	-.24 (.00)	.08 (.39)	-.04 (.24)		.31	.69
Netherlands	ΔI	.40 (.00)	.32 (.01)	-.24 (.03)	.14 (.00)	.56	.76
	ΔCA	.05 (.69)	.24 (.10)	.13 (.14)		.12	.03

*1968-1990

Note: Marginal significance levels in parentheses. Q-msl is the marginal significance level of the Box-Ljung Q-statistic for serial correlation.

Table 3a

Individual Country Time-Series Regressions, 1961-90
Newey-West Marginal Significance Levels

$$\Delta Z_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T$$

Country	ΔZ	b_1	b_2	b_3	$b_4 \times 10^2$	R^2
U.S.	ΔI	.19 (.09)	.41 (.00)	-.22 (.24)	.11 (.23)	.53
	ΔCA	-.13 (.10)	.01 (.92)	.04 (.36)		.12
Japan	ΔI	.42 (.00)	.58 (.00)	.09 (.25)	.06 (.53)	.68
	ΔCA	-.14 (.00)	-.06 (.41)	-.04 (.06)		.19
Germany	ΔI	.46 (.00)	.52 (.00)	-.15 (.05)	.13 (.00)	.55
	ΔCA	-.21 (.12)	.01 (.93)	.02 (.82)		.12
France	ΔI	.45 (.00)	.44 (.01)	-.14 (.09)	.14 (.01)	.36
	ΔCA*	-.07 (.59)	.03 (.86)	.01 (.82)		.03
Italy	ΔI	.60 (.00)	.27 (.16)	-.17 (.25)	.16 (.04)	.65
	ΔCA	-.30 (.01)	-.11 (.46)	-.03 (.49)		.24
U.K.	ΔI	.49 (.00)	.65 (.00)	.05 (.57)	.00 (.83)	.76
	ΔCA	-.46 (.00)	-.20 (.02)	.00 (.94)		.49
Canada	ΔI	.42 (.03)	.16 (.29)	-.12 (.46)	.13 (.34)	.44
	ΔCA	-.24 (.01)	.08 (.43)	-.04 (.17)		.31
Netherlands	ΔI	.40 (.00)	.32 (.00)	-.24 (.00)	.14 (.00)	.56
	ΔCA	.05 (.62)	.24 (.03)	.13 (.02)		.12

*1968-1990

Note: Marginal significance levels for t-statistics from Newey-West heteroskedastic and autocorrelation consistent estimates of covariance matrix are in parentheses.

Table 4

Pooled Time-Series Regressions, 1961-90

$$\Delta Z_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T$$

With Country-Specific Time Trends

ΔZ	b_1	b_2	b_3
ΔI	.33 (.00)	.48 (.00)	-.15 (.00)
ΔCA	-.15 (.00)	.02 (.44)	.05 (.09)
ΔY	.42 (.00)	.59 (.00)	.01 (.68)
ΔC	.15 (.00)	.23 (.00)	-- --

Without Time Trends ($b_4 = 0$)

ΔZ	b_1	b_2	b_3
ΔI	.33 (.00)	.52 (.00)	.07 (.00)
ΔCA	-.13 (.00)	-.01 (.47)	-.01 (.10)
ΔY	.41 (.00)	.65 (.00)	.15 (.00)
ΔC	.14 (.01)	.20 (.00)	-- --

Note: France excluded from ΔCA regressions. Figures in parentheses are marginal significance levels.

Table 5

Pooled Time-Series Regressions, 1961-90

$$\Delta I_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T + b_5 \left(\bar{G}_t^w - E_{t-1} \bar{G}_t^w \right)$$

b_1	b_2	b_3	b_5
.33 (.00)	.48 (.00)	-.15 (.00)	-.28 (.56)

$$\Delta CA_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T + b_5 \left(\bar{G}_t^c - E_{t-1} \bar{G}_t^c - \Delta G_t^c \right)$$

b_1	b_2	b_3	b_5
-.15 (.00)	.02 (.43)	.05 (.07)	-.36 (.30)

Note: Country-specific time trends not reported. France excluded from ΔCA regression. Figures in parentheses are marginal significance levels.

Table 6

Pooled Time-Series Regressions, 1971-85

OECD Total Factor Productivity Data

$$\Delta Z_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T$$

With Country-Specific Time Trends

ΔZ	b_1	b_2	b_3
ΔI	.34 (.00)	.39 (.00)	-.11 (.12)
ΔCA	-.26 (.00)	.05 (.01)	.06 (.08)
	Without Time Trends ($b_4 = 0$)		
ΔI	.38 (.00)	.40 (.00)	-.01 (.24)
ΔCA	-.27 (.00)	.03 (.09)	.00 (.77)

Note: France excluded from ΔCA regressions. Figures in parentheses are marginal significance levels.

Table 7

Pooled Time-Series Regressions, 1975-90

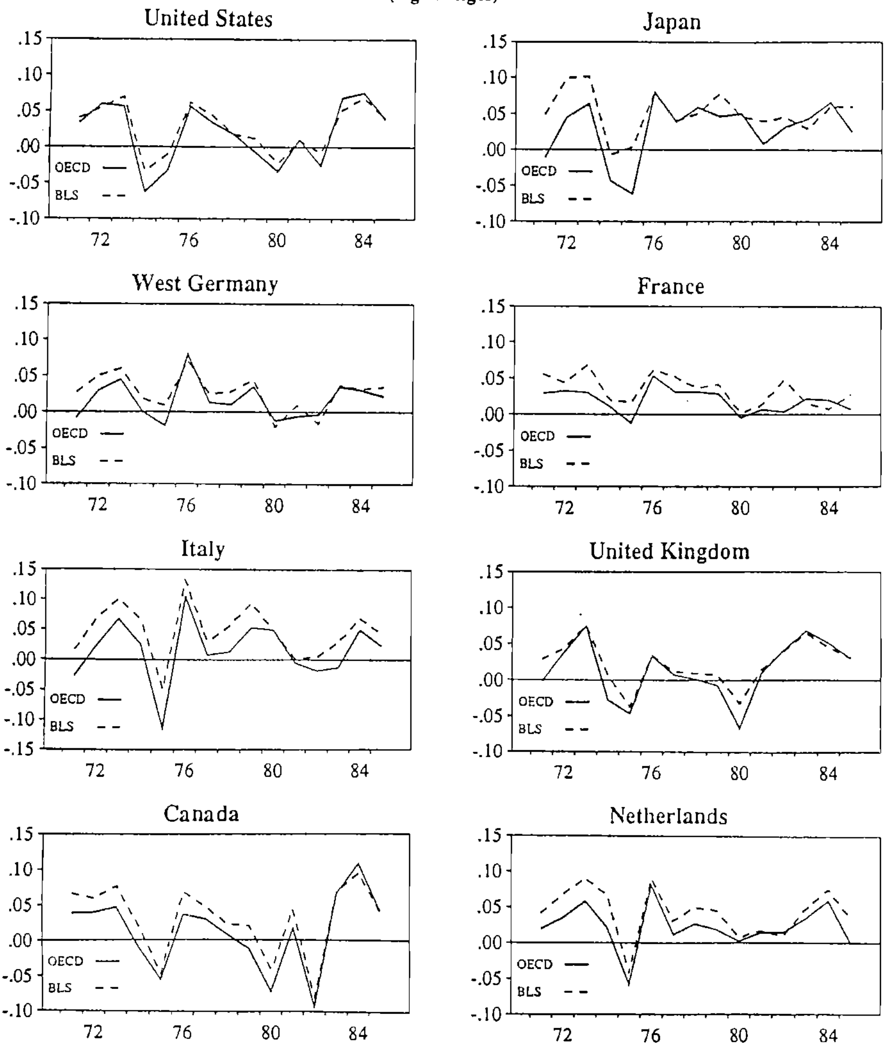
$$\Delta Z_t = b_0 + b_1 \Delta A_t^c + b_2 \Delta A_t^w + b_3 I_{t-1} + b_4 T$$

With Country-Specific Time Trends

ΔZ	b_1	b_2	b_3
ΔI	.36 (.00)	.64 (.00)	-.05 (.35)
ΔCA	-.27 (.00)	.03 (.13)	.07 (.04)
Without Time Trends ($b_4 = 0$)			
ΔI	.34 (.00)	.60 (.00)	.00 (.90)
ΔCA	-.25 (.00)	-.01 (.62)	.01 (.59)

Note: France excluded from ΔCA regressions. Figures in parentheses are marginal significance levels.

Figure 1
Total Factor Productivity in Manufacturing
(log changes)



Note: See text for construction of Bureau of Labor Statistics and OECD measures of total factor productivity in manufacturing.