Does Cash Flow cause Investment and R&D: An Exploration Using Panel Data for French, Japanese, and United States Scientific Firms*

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ABSTRACT

The role of financial institutions and corporate governance in the conduct and performance of industrial firms, especially in the area of technological innovation and international competition has been hotly debated in the recent past. The results presented here are a contribution to the empirical evidence on the behavior of individual firms that exist in somewhat different institutional environments. Using a Panel Data version of the Vector Auto Regressive (VAR) methodology, we test for causal relationship among sales and cash flow on the one hand and investment and R&D on the other, using three large panels of firms in the scientific (high technology) sectors in the United States, France, and Japan. Our findings are that both investment and R&D are more highly sensitive to cash flow and sales in the United States than in France and Japan. Correspondingly, both investment and R&D predict both cash flow and sales positively in the United States, while the impact is somewhat more mixed in the other countries.

Keywords: corporate finance, panel data, liquidity constraints, international comparisons.

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1 Introduction

It is a widely held view that the capital market and corporate governance systems of such countries as France, Germany, and Japan differ in important ways from those of the so-called "Anglo-Saxon" countries, the United States, the United Kingdom, and possibly Canada. Those who hold this view argue that features such as interlocking directorates, large scale shareholding by banks, restrictions on and the absence of hostile takeover activity, relatively less active share markets, and a general tendency to rely on voice rather than exit lead to more extensive monitoring by large institutional shareholders and possibly to a greater willingness on the part of firms to undertake long term risky investments than exists in the more actively traded capital markets of the United States and the United Kingdom.[2]

If this view is accurate, it is natural to ask whether one can see its effects in the investment patterns of firms in these countries, and in their relationship to such indicators of financial performance as sales and cash flow. We think that looking at the dynamic relationships of output measures such as deflated sales and cash flow with investment inputs (both tangible and intangible) in similar samples of firms in a comparison group of countries is one way to investigate whether the institutional difference in these countries, which undoubtedly exist,

[1]Nuffield College, Oxford University, University of California at Berkeley and NBER; INSEE/CREST, EHESS, and NBER; University of California at Davis and NBER; INSEE, Paris. .

[2]Among others, see Franks and Mayer (1990) [France, Germany, and the U.K.], Kester (1992) [Japan and Germany], Mayer and Alexander (1990) [Germany and UK], and Hoshi, Kashyap, and Scharfstein (1990) [Japan], Hall (1994) [U.S. plus some international comparisons], and Soskice (1995) [Germany, Japan, U.S., U.K., and France] for evidence on this topic.

have consequences for the real behavior of firms. If we cannot see evidence of differences at this level, then it seems unlikely that the contrasting institutional features can be having much of an impact on the firms' actual performance.

In Mairesse and Hall (1996), two of us explored the simultaneity between output (sales) and inputs (capital stock, labor, and R&D capital) while estimating production functions for the United States and France. During the course of this exploration, we found evidence that investment in both research and development and in physical capital were more sensitive to sales growth in the United States than in France, suggesting that either demand shocks or liquidity constraints play a more important role in determining investment in the former country than the latter. In work closely related to ours, Bond, Elston, Mairesse, and Mulkay (1995) found that investment spending in UK firms was more sensitive to cash flow or profits than investment spending in French, German, or Belgian firms; their finding was robust to changes in specification of the investment equation. They did not consider research and development investment in their work.

The current paper explores the finding in the earlier work of Mairesse and Hall and extends it by including cash flow as a variable in addition to sales, employment, and investment of both kinds (tangible and R&D), and by augmenting the data samples with data on another country whose institutions differ from both those in the United States and France, that is, Japan. For data reasons, and because we are particularly interested in the role played by country environments in the encouragement of industrial innovation and technical change, we restrict our sample in this paper to firms in the scientific or high technology sectors in these countries, that is, Chemicals, Pharmaceuticals, Electrical Machinery, Computing Equipment, Electronics, and Scientific Instruments.[3]

Our second motivation in undertaking this study is an interest in exploring further the use

[3] We have excluded aircraft and aerospace because of the large share of federal government spending on investment in these industries, and the role of the federal government as the primary customer for the output, which means that these industries behave quite differently in these three countries, for reasons largely unrelated to our central interest.

of efficient Generalized Method of Moments estimation on panel data where we allow for the presence of both correlated effects and lagged dependent variables. In this, our immediate inspiration was Holtz-Eakin, Newey, and Rosen (1988), although we have also made use of ideas in Arellano and Bond (1991), Arellano and Bover (1994), and Blundell and Bond (1995). An appendix to this paper chronicles some of our simulation experience with the problem of distinguishing a model with correlated effects from one in which there are no effects, but where each firm's data follows an autoregressive process with a unit root in short panels. Our conclusions are twofold: First, we find that it is frequently difficult to distinguish the two when the lag length is unknown. Second, instrumental variable estimation (GMM) of models with correlated effects is subject to substantial finite sample bias even in fairly good-sized sample sizes (approximately 300-400 firms), when the number of time periods available is fairly large (12 years, in our case) and the efficient estimator is used.[4] Because of this, we use a slightly less efficient estimator in the body of the paper (one with fewer instruments and therefore fewer orthogonality conditions) that is somewhat better behaved.

This paper begins with a discussion of the issues raised by comparative corporate governance studies, most of which are fairly qualitative, for the examination of firm-level behavior across G-7 countries. Then we describe our datasets, and how we attempt to make them as comparable as possible across the three countries we consider. We present some basic descriptive data in order to illustrate the similarities and differences. In a related paper (Hall and Mairesse 1998), we explore the question of whether the univariate time series properties of our basic variable set (deflated sales, R&D investment, ordinary investment, number of employees, and cash flow before investment and taxes) suggest the presence of correlated firm effects or whether they display unit root behavior. Our conclusion here is that it is extremely difficult to distinguish the two in these data because of the short length of the time period and the fact that the instruments available for differenced estimation are weak if the data is close to a random walk.

[4]In the case here, where we have lagged predetermined variables as regressors (not strictly exogenous) and fixed firm effects, the number of orthogonality conditions in the efficient GMM estimator increases at the rate T^2 in general.

We have included permanent firm effects in all the models in the subsequent section, although only it is probably that only investment is the only stationary process in these data.[5]

Section 4 contains the meat of the paper: the results of bivariate causality testing between our two output measures (deflated sales and cash flow) and our two investment measures (R&D and ordinary investment). In future work, we plan to expand the bivariate model to control for other variables, but we believe that the current results are worth reporting even in the absence of such controls.

2 Corporate Governance and the Market for Corporate Capital

In the recent past, many economists and other researchers have attempted to characterize the contrasting styles of corporate governance in the major industrial economies. This research has been spurred by a general increase in global competition during the nineteen-eighties: this increased competition simultaneously revealed the comparative strength of economies like Germany and Japan, especially in manufacturing, and caused substantial turbulence in the United States and United Kingdom, turbulence driven partly by a perceived need to restructure and shrink industries in the face of increasing foreign competition. Although the particular set of considerations that focused attention on these issues may have lost importance in the most recent past, the question of whether institutions "matter" for the performance of the industrial sector of an economy is still an interesting and important one.

The fact that corporate governance and financing institutions differ across the three countries considered here (the United States, France, and Japan) is not in question. The issue is whether selection operates in such a way as to undo the possible negative effects that each set of institutions might have as the institutions evolve, causing the actual observed behavior of firms in these countries to be closer than implied by the caricatures of the corporate governance

[5]It is clear that all of the series are either nonstationary OR have a fixed firm effect. It is distinguishing these two possibilities in the presence of serially correlated disturbances that is the difficulty.

literature. As Gilson (1995) points out, institutions can differ at first, but if they do not function effectively, they will either be selected out, or they may evolve some of the characteristics toward those of successful institutions. As an example of the forces that push institutions to evolve, consider the rise of EASDAQ in Europe and the attempts to create a successful capital market for new firms and startups in France. In this paper, we focus on the consequences of institutional differences across the three countries for the investment behavior of individual technology firms.

Table 1 presents a stylized view of the corporate governance structures in the U.S., France, and Japan that is due to David Soskice (1995); one can find similar discussions in other places, see Charkham (1994), for example. This table focuses on a set of relationships between an industrial company and its owners: who the owners are, how they monitor the behavior of the firm, what happens when restructuring is necessary, and the incentives faced by the Chief Executive Officer. The major contrast is between Japan and the U.S.: in the former country, even when ownership is dispersed, the management of the shares tends to be delegated to large shareholders (like banks), and monitoring and restructuring tends to be done by the main bank or major shareholder in the firm. Public financial markets place relatively little pressure on the firm. In the latter country, the opposite picture prevails: ownership is dispersed, and the monitoring of the firm and restructuring take place in public. Because considerable data on the firm's activities is publicly available, monitoring by outsiders and shareholders is somewhat easier (although incentives to monitor are low for small shareholders, of course). And restructuring is often achieved via hostile takeover or acquisition by outsiders rather than quietly within the firm or its keiretsu.

The situation in France is somewhere in between the other two, possibly leaning toward the Japanese system. There are more large block shareholders, and many small shareholders hold "bearer" shares, which imply that there is no way a firm can supply information directly to these shareholders, even if it wanted to. Therefore monitoring tends to be done by a few shareholders, banks, or even the government in the case of firms that are wholly or partially government owned. Restructuring tends to be managed within a fairly elite network of private/public managers and holding companies, and is not often hostile as it is in the United States.

TABLE 1

A Stylized View of Corporate Governance Structures in the 1980s

Company-Owner Relationship	U.S.	France	Japan
Ownership	dispersed	delegated monitoring	delegated monitoring
Monitoring	public data	unsystematic; evolving	direct; product market
Restructuring	takeovers	decisions within an elite network	main bank
CEO's incentives	high powered; market-oriented	public-private network for promotion	low power; company men
Length of financial commitment	SHORT	LONG?	LONG

Source: *David Soskice, presentation to WZB, June 22, 1995.*

Based on these comparisons of owner-manager relationships, many have suggested that company owners in the United States will tend to have a much shorter-term commitment to the firms in which they hold shares, whether or not they actually trade them more often. In fact, financial markets in the United States are quite accommodating to this kind of shareholder, as they are very thick and active. Thus "exit" is viewed as a viable option by an unhappy shareholder in the U.S., while less so in the other two countries, where "voice" is more likely to be used. That is, shareholders in different countries are somewhat self-selected in response to the institutional differences, with greater concentration and/or a willingness to hold shares for a longer period in France and Japan than in the United States.

The conclusion of this kind of argument is the suggestion that firms in the United States may try harder to satisfy shareholders in the short run, rather than taking a long term view.[6] Thus, an implication of this world view is that firms in Japan and France may find it easier to undertake longer-term investments. A second implication is that because they do not have to go to the external capital markets to finance new investment, but can potentially rely on agents that are not in the public market (either their main bank or another firm in the group in Japan, and an informal network or the government in France), firms in these two countries may be less subject to "liquidity constraints" when undertaking investment. It is this possibility that we explore in this paper, where we compare the bivariate relationship of cash indicators such as sales and cash flow with investment and R&D across the three countries. We ask two questions: First, what does conventional causality testing have to say about the relationship? Does our cash proxy cause investment or the other way around? Second, what is the size of the impact of lagged cash on investment or R&D? Does it vary across countries?

3 Data and Descriptive Statistics

Our goal is to produce similar samples of high-technology manufacturing firms for each of our countries: France, the United States, and Japan. However, our sources of data are quite different and this means that the samples will never be exactly comparable, although they are quite representative. Table 2 gives the sources of our data, our deflators, and some indication of the number of observations available to us, both before and after cleaning. The primary difference in the data sources is between France and the other two countries: in France, we have access to a Census of Manufactures-type sample with R&D data collected in survey form by the government for the *Ministere de la Recherche*. This means the data tend to be at a

[6]Obviously perfect capital markets would overturn this result easily; in markets that correctly value the expected present discounted value of the future returns to investment, it makes no difference what the horizon of an individual investor is. But there is some empirical evidence that this theoretical prediction is not always true, and the apparent persistence of the belief on the part of firms that they must manage their stock price quarterly suggests that we cannot ignore the possibility that short-termism in ownership may lead to some short-termism in investment.

level somewhat lower than that of consolidated accounts (the "group" level), and that it is not confined to publicly traded firms.[7] For the other two countries, we have data based on the filings of publicly-traded firms with agencies charged with monitoring the financial markets. Although the Japanese data are somewhat less consolidated than those for the United States, in the sense that they are not at the "group" level, they are consolidated to a level roughly comparable to that in the United States. Also in the case of Japan, the R&D data has been augmented with data from another survey, because the quality of publicly reported R&D data is very uneven.[8]

The deflators also differ somewhat across countries. In all cases, we deflate R&D, investment, and cash flow by a deflator that is common across all industries.[9] On the other hand, we have attempted to varying degrees to construct real output measures rather than sales by deflating our sales figures by at least a 2-digit-level deflator. In the United States, we are using deflators aggregated up to the 2-digit level from the NBER Productivity Database, which is at the 4-digit level (Bartelsman and Gray 1994). In France, we are using the N40 industry level deflator (approximately 2-digit), which do not contain very much of the type of hedonic quality adjustment that is used in the United States. In Japan, we have constructed "firm-level" deflators based on the 4-digit industry composition of the firm's output.

Our choice of years (1978-1989) reflects data availability, as well as a desire to have a fairly long time series available for each variable for use in instrumental variables estimation. Because these datasets are large, and in some cases fairly dirty, and because we want to focus

[7]In this, our problem is similar to that of Bond et al (1995), who had consolidated data for the UK and not for France, Germany, and Belgium. This feature of our data makes things particularly difficult, since it is driven fundamentally by the same institutional differences on which we have focused our interest. That is, the existence of an active public equity market means that data are publicly available at the level of the consolidated firm or at the level at which the shares trade. Absent this market, one is forced to use government or Central Bank data (as in France, Germany, and Japan), and such data tends to be unconsolidated. This may have implications for the "softness" of the budget constraint faced by the firm, but it is exactly that difference in which we are interested. The ideal exercise would be to compare estimates at different levels of consolidation. Bond et al (1995) have begun such an exploration.

[8]See Griliches and Mairesse (1990) for further discussion of this point.

[9]Thus we are implicitly assuming that the market for capital goods, and the market for R&D are common across all our firms, so they face the same prices. In fact, even when measured carefully, there is little variation in the relative price of investment goods across industries, so our procedure is unlikely to produce much bias.

on the common time series properties across firms, rather than isolated reorganizations and other specific disturbances, we apply cleaning rules to all the variables: First, we require their growth rates to be between -90% and 900%. Second, in order to remove erroneous data values that might produce misleading autoregressive estimates, we remove firms that have sequential growth rates that are large and alternate in sign. For sales and employment, large is defined as below -50% or above 100%; for R&D, it is -67%, 200%; for investment and cash flow, it is -80%, 400%. Finally, we work with the logarithms of all the variables, in order to minimize heteroskedasticity and problems with influential outliers.

After cleaning, and requiring a full 12 years of data for each firm, we are left with 204 firms for the United States, 156 for France, and 221 for Japan. Table 3 gives some indication of the typical size of these firms, and their importance in their national economies. Each sample is a small but not insignificant portion of its economy, and a larger fraction of that economy's private R&D activity. The Japanese sample has the largest coverage of both GDP and BERD (Business Enterprise R&D) and the French sample the smallest. Although the national R&D intensities are ranked Japan (2.2%), the U.S. (2.0%), and France (1.6%), the typical firm in these samples is more R&D-intensive in the U.S. (with an R&D to sales ratio of 4.0%), followed by France (3.6%) , and then Japan (2.8%). This perhaps reflects the somewhat greater selectivity of the U.S. and French samples, and the large integrated firm structure typical of Japan. Because of this vertical integration, we suspect that our Japanese firms are slightly less concentrated in the high-technology sector than the sample of firms from the other two countries.

TABLE 2

Dataset Characteristics

	France	**United States**	**Japan**
Source	Enquete annuelle sur les moyens consacres a la recherche et au developpement dans les entreprises; Enquete annuelle des entreprises	Standard and Poor's Compustat Data - annual industrial and OTC, based on 10-K filings to SEC	Needs data; data from JDB (R&D data from Toyo Keizai survey)
Scientific Sector*	1978-89, good R&D	1978-89, good R&D	1978-89 good R&D
# firms	953	863	424
# observations	5,842	6,417	5,088
Cleaned (#obs.)	5,139	5,721	4,260
No jumps (#obs.)	5,108	5,312	4,215
Balanced 1978-89			
(#obs.)	1,872	2,448	2,652
(# firms)	156	204	221
Positive Cash Flow			
(# firms)	104	174	200

*This sector consists of firms in Chemicals, Pharmaceuticals, Electrical Machinery, Computing Equipment, Electronics, and Scientific Instruments.

TABLE 3

Sample Comparison

The Median Firm (National Currency)

Variable	United States ($M 1987)	France (M FF 1987)	Japan (100M yen 1987)
Sales	249.0	465.6	570.6
R&D	9.8	16.2	15.1
Investment	14.0	15.3	42.4
Cash Flow	43.9	59.7	62.1
Employment (numbers)	2,762	604	1,732

The Median Firm (at PPP Exchange Rates in $M 1987)

Variable	United States	France	Japan
Sales	249.0	67.3	283.5
R&D	9.8	2.4	7.6
Investment	14.0	2.1	21.1
Cash Flow	43.9	8.4	30.0
1989 GDP ($N87)*	4,730.	758.	1,885.
Sample Sales/GDP	10.1%	5.4%	17.1%
1989 BERD ($B87)**	93.9	12.0	40.9
Sample share of BERD	29.9%	21.0%	41.2%

*GDP in 1989$ at PPP exchange rates is from OECD (1991a), converted to 1987$.

**BERD is Business Enterprise R&D, from OECD (1991b) in 1989$ at PPP exchange rates (approximately 7 francs per $ and 200 yen per $.

Figures 1 and 2 display the trends in the median growth rates and interquartile ranges for the three samples. The first thing to note in these figures is that there is more difference in the patterns among the variables than among the countries, with cash flow and ordinary investment fluctuating much more over the cycle than sales, R&D, and employment. The dispersion of growth rates in all 3 countries (measured by the interquartile range within each year) is also quite similar across the variables, except for the rather anomalous cash flow range in France. It is perhaps worth noting also that the fluctuations of the median and interquartile dispersion of employment growth rates are somewhat higher in the United States, although relatively low in all 3 countries. In other words, over the business cycle large manufacturing firms tend to increase and decrease employment more in the United States than in Japan and France, and the variance across firms of this behavior is also higher, facts that are consistent with the oft-cited flexibility of the U.S. labor market.

[Figures 1 and 2 about here]

Figure 3 shows the trends in three ratios over the three countries: the median R&D intensity (measured as R&D to sales), the median investment to sales ratio, and the median cash flow to sales ratio. The R&D to sales ratio is flat in France, while it increases during the period in both the U.S. and Japan. The Japanese capital expenditure rate is higher than the U.S. and the French rate lower throughout the 1980s. By the end of the period, both the U.S. and France have R&D intensities for these samples of firms that are within one percentage point of the investment to sales ratio, while Japan's is still somewhat lower (just over 3 percent for R&D as compared with 7 percent for capital expenditures).[10] The levels and trends in cash flow differ considerably across countries: roughly constant in the United States and Japan and increasing in France, with the rate much higher overall in the United States. This cash flow measure is

[10] As mentioned earlier, this difference probably reflects the level of vertical integration in the Japanese firms.

approximately equal to revenues less labor and material costs in all three countries: that is, it is should be a measure of cash available for both kinds of investment, as well as for payments to shareholders, possibly bondholders, and the government. The final panel of Figure 3 shows the cash flow to sales ratio net of these two investment streams: by the end of the 1980s, the cash flow available for shareholder payments is approximately zero for Japan, while it is still quite positive and of roughly the same order of magnitude for France and the United States.

[Figure 3 about here]

As a final summary of the data relationships in our three samples, we present the simple correlations of the growth rates of our five key variables in Table 4. With the exception of the correlation of R&D growth and cash flow growth (which may be related to the way the data was constructed), in all cases the correlations are highest for the United States.

TABLE 4

Correlation of Deflated Growth Rates: 1978-1989

	Sales	R&D	Investment	Employment
R&D	.324, .138, .208			
Investment	.314, .231, .258	.181, .146, .095		
Employment	.609, .551, .197	.271, .170, .118	.376, .262, .172	
Cash Flow	.561, .142, .531	.130, .100, .212	.165, .061, .166	.294, .059, .048

The order of the correlations in each cell of the above table is U.S., France, Japan. The number of firms is 204, 156, and 221 respectively, except for the cash flow correlations, where the numbers are 174, 104, and 200 (see Table 2 for details on the sample).

From this survey of the main features of our samples, we conclude that there are no real surprises in the data: as expected, the United States generally exhibits higher correlations of most variables with cash flow, and United States employment fluctuates more over the cycle. In addition, the Japanese tangible investment rate is quite high, and there is a tendency to invest at a much higher rate out of profits in Japan. However, we also found some evidence that the samples may not be completely comparable, in that the vertical integration in the Japanese firms seems to be greater, leading to a sample that is less concentrated in the particular sector on which we are focusing our attention. Of course, this fact is yet another reflection of the differences in corporate institutions across the three economies, and not an "error" in constructing the samples.

4 Bivariate Causality Testing

As we discussed earlier, the central goal of this paper is to describe the differences in the "causal" relationship or dynamics between R&D and investment on the one hand and sales and cash flow on the other across three economies that have different institutional structures for corporate governance and finance. In this section of the paper, we perform this exercise using conventional Granger-causality testing. That is, we ask questions like the following: "Conditional on past R&D behavior and on average R&D behavior over the sample, does cash flow help to determine future R&D in the firm?" To perform these tests, we use a methodology similar to that of Holtz-Eakin, Newey, and Rosen (1988).

In Hall and Mairesse (1998), we present a series of investigations into the univariate time series processes that describe our data and reach the following conclusions: 1) Tests for the absence of correlated firm effects are somewhat inconclusive, and 2) because the first differenced series often display near random walk behavior, the small sample bias of instrumental variable estimation persists even when the sample is fairly good-sized. For these two reasons, we specify our two variable model for causality testing with a permanent firm effect, and we estimate our model using GMM with a restricted set of lagged level variables as instruments. Our maintained model is the following:

$$y_{it} = \alpha_i + \delta_t + \sum_{s=1}^{m} \beta_s y_{it-s} + \sum_{s=1}^{m} \gamma_s x_{it-s} + \varepsilon_{it} \tag{1}$$

$$i = 1, ..., N \text{ firms} \qquad t = 1, ..., T \text{ years } (T = 12)$$

α_i is a correlated firm effect and δ_t are year dummies. ε_{it} is a serially uncorrelated disturbance (when m is large enough).

After differencing, the appropriate orthogonality conditions for GMM use lagged x's and y's as instruments. We use a maximum of 5 lags, based on our experience with finite sample bias in GMM when the full set of orthogonality conditions is used. Our assumptions imply the following set of orthogonality conditions:

$$E[z_{ir}\Delta u_{it}] = 0 \qquad t = m+2, ..., T; \qquad r = \max(1, t-6), ..., t-2 \tag{2}$$

where $\Delta u_{it} = \Delta y_{it} - \Delta\delta_t - \sum_{s=1}^{m} \beta_s y_{it-s} - \sum_{s=1}^{m} \gamma_s x_{it-s}$ and $z_{ir} = [x_{ir} \ y_{ir}]$. For example, there are $2 \cdot 5 \cdot (T-m-1)$ orthogonality conditions in (**??**) when $m = 5$ plus $T-m-1$ for the year dummies for a total of $11 \cdot (12-6) = 66$.[11]

Using (**??**) as our basic specification, we conduct the following tests: First, Arellano and Bover (1994) suggested that lagged Δx's and Δy's can be used as instruments for equation (**??**) in levels. Blundell and Bond (1995) show that this is valid if the initial deviation ε_{i1} is not correlated with the initial level of y, which is proportional to the firm effect α_i. We test for the validity of this restriction (notated AB in the tables) by adding equation (**??**) to our estimation and usually accept the restriction:

$$E[\Delta z_{it-1} u_{it}] = 0 \quad t = m+2, ..., T \qquad (2(T-m-1) \text{ additional restrictions}) \tag{3}$$

Second, conditional on the results of our test of Arellano and Bover's restriction, we choose the length of the lag from $m = 2, 3, 4, or 5$. At the chosen length, we check that the A-B restriction still holds. Once we have a preferred specification, we test for causality with a joint test of the significance of the γ's . If we accept zero γ's, then x does not cause y. If we reject, x causes y or a third variable causes y (orboth). The results of this procedure for the sales,

[11]Computing the number of OCs is somewhat more complicated when M<5. For example, suppose $T = 12$ and $m = 3$. Then the periods used for estimation are 5 through 12, and the instruments for Δu_{i5} are $(x_{i1}, x_{i2}, y_{i1}, y_{i2})$; those for Δu_{i6} are $(x_{i1}, x_{i2}, x_{i3}, y_{i1}, y_{i2}, y_{i3})$; those for Δu_{i8} are $(x_{i1}, x_{i2}, x_{i3}, x_{i4}, x_{i5}, y_{i1}, y_{i2}, y_{i3}, y_{i4}, y_{i5})$, and those for Δu_{i12} are $(x_{i5}, x_{i6}, x_{i7}, x_{i8}, x_{i9}, y_{i5}, y_{i6}, y_{i7}, y_{i8}, y_{i9})$. This yields a total of $2(2+3+4+5*5) = 68$ OCs plus the 8 for the intercept (year dummies) for 74 in all.

cash flow, R&D, and investment variables are shown in Appendix A and summarized in Tables 5 and 6.

The tables in Appendix A are organized in the following way: The top panels show the length of lag m that was chosen, together with the results of the causality tests with and without the AB restriction imposed. The bottom panels show the actual coefficient estimates at the chosen lag length; the estimated sums of the coefficients are shown in Table 6. We also show the results of the test for the validity of this restriction, which is accepted easily in most cases. The exceptions are the relationship between cash flow and both investment and R&D in Japan, and more weakly, between investment and sales in France and Japan. This implies that in general the random year-to-year disturbances in sales, cash flow, and R&D are not correlated with the initial levels of these variables. In some, but not all, cases, adding the orthogonality conditions implied by AB reduces the standard errors substantially.

Table 5 summarizes the results of the causality testing, choosing the test that is based on the estimates with AB imposed where that restriction is accepted at the one percent level, and the other test if it is rejected. The causality tests themselves are not very meaningful in an accept-reject sense, since they almost all reject noncausality; that is, the second (x) variable helps to predict the first (y) variable even in the presence of y's own lags. The only cases where we can accept non-causality is in France, where sales does not cause investment and Japan, where investment does not cause sales. However, the magnitude of the test statistic and the sum of the lag coefficients on the variables display a large amount of rather systematic variation and are quite informative.

The bottom panels of the tables in Appendix A give the full set of estimated lag coefficients for each bivariate regression, again with and without AB imposed. We summarize these results in Table 6, which shows the sum of the lag coefficients for the chosen regressions, for each pair of variables, and for each country, 24 regressions in all.

From the perspective of the question we posed at the beginning, the results in Table 6 are very striking: the U.S. data display a high predictive power of cash flow for both R&D and investment, particularly when contrasted with France and Japan. The coefficients of cash flow in both the R&D and investment regressions are strongly positive in the United States, and very small in the other countries, except for investment in Japan, whose coefficient is half the level of that in the United States. For whatever reason, liquidity or flexibility in the face of demand shocks, large U.S. scientific sector firms seem to be more sensitive to cash flow changes. The results for sales are quite similar, although the contrast between the countries is somewhat weaker in the case of R&D.

At the same time, the role of investment in generating future cash flow appears to be somewhat weaker, possibly zero in Japan and negative in France. The impact of R&D investment on future cash flow in Japan is also zero, but in the U.S. and France, it is much higher than the impact of ordinary investment.

The sales regressions display the same kind of results, but much weaker: in this case sales growth clearly predicts R&D growth in all three countries, although somewhat more strongly in the United States. The converse is that R&D does not appear to cause future sales growth, except in the United States, and even here the coefficient is small (on the order of .09).[12] Investment appears unrelated to future sales in all three countries.

[12] It is worth noting that the magnitude of this coefficient is approximately equal to the estimate obtained using production function estimation with sales growth as the dependent variable and the growth in capital, labor, and R&D capital as the independent variables (see Mairesse and Hall 1995). Thus our estimates here are consistent with the traditional TFP regression approach, but they highlight the fact that the simultaneity that we observed in the relationship between the inputs and output of the production process may be much more important running from output to input than from input to output.

TABLE 5

Causality Testing

	United States	France	Japan
Number of Firms	174	104	200
Does CF cause I?	111.3 (4) **	12.6 (5) *	71.4 (4) **
Does CF cause R?	235.2 (4) **	67.3 (3) **	16.3 (3) **
Does I cause CF?	40.7 (3) **	26.7 (5) **	25.5 (4) **
Does R cause CF?	42.0 (3) **	116.9 (4) **	25.6 (3) **
Number of Firms	204	156	221
Does S cause I?	84.8 (3) **	6.6 (4)	77.6 (4) **
Does S cause R?	200.7 (4) **	133.0 (4) **	57.2 (3) **
Does I cause S	35.0 (5) **	14.0 (4) **	8.0 (5)
Does R cause S?	39.5 (4) **	13.7 (3) **	38.0 (4) **

In each case, the statistic shown is a chi-squared (degrees of freedom) for the hypothesis that the lagged "causal" variables do not enter the equation once the appropriate lags of the dependent variable are included. That is, the statistic 111.3 (4) is the joint significance of the first 4 lags of the logarithm of cash flow in an equation with the logarithm of investment as the dependent variable and 4 lags of the logarithms of cash flow and investment as the independent variables.

TABLE 6

Sums of the Estimated Lag Coefficients: Bivariate Regressions

Investment and R&D with Cash Flow

Dep. Var.	Lag Indep. Vars.	United States	France	Japan
Investment	Investment	-.111 (.074)	-.607 (.053)	-.007 (.066)
	Cash Flow	.825 (.086)	.081 (.099)	.411 (.075)
R&D	R&D	.316 (.038)	-.124 (.019)	-.066 (.037)
	Cash Flow	.431 (.031)	.124 (.020)	.042 (.059)
Cash Flow	Cash Flow	.101 (.043)	-.578 (.052)	-.372 (.054)
	Investment	.075 (.038)	-.170 (.080)	.039 (.049)
Cash Flow	Cash Flow	-.235 (.046)	-.303 (.050)	-.413 (.047)
	R&D	.226 (.060)	.345 (.053)	.023 (.028)

Investment and R&D with Sales

Dep. Var.	Lag Indep. Vars.	United States	France	Japan
Investment	Investment	-.008 (.050)	-.192 (.099)	-.183 (.086)
	Sales	.608 (.073)	-.181 (.197)	.171 (.137)
R&D	R&D	-.055 (.053)	.142 (.053)	.167 (.022)
	Sales	.628 (.053)	.536 (.071)	.408 (.057)
Sales	Sales	.562 (.061)	.006 (.068)	.362 (.066)
	Investment	-.127 (.047)	.013 (.025)	.038 (.039)
Sales	Sales	.170 (.062)	.086 (.052)	.705 (.029)
	R&D	.092 (.045)	-.056 (.028)	-.004 (.016)

The table shows the sum of the estimated lag coefficients together with their standard errors in parentheses for the 8 bivariate regressions reported in Table 5, one set for each country.

5 Conclusions

We view these results as rather preliminary, but highly suggestive. The oft-told story of a softer budget constraint on investment in the major continental countries and Japan when compared to the United States is clearly supported by our analysis. However we would be extremely cautious about drawing strong conclusions from these data yet, for two quite different sets of reasons. First, findings like those here do not automatically imply that liquidity constraints are at the root of the differences: what we may be seeing is a greater flexibility of firms in the United States in all dimensions when faced with demand shocks; consider the evidence of the employment fluctuations. In addition, we have not fully explored the question of whether the "softer" budget constraint that may exist in the absence of active public financial market discipline means more or less productive investment, although the evidence of the reverse regressions is slightly daunting in this regard; in many cases we see no positive impact on sales and cash flow from investments as long as four years after they are undertaken.

The other reason for caution is the limited nature of our analysis thus far. First, bivariate regressions may not control properly for changes in other closely related factors; for example, it is more natural to include capital and labor when regressing sales on R&D, and surely investment and R&D are related in their impacts on cash flow. Extensions to this paper will conduct the causality testing in a multivariate setting. Second, we found in Appendix A that many of our univariate time series displayed random walk behavior. This suggests that a fruitful avenue of exploration might be to look for cointegration between our main variables in the spirit of recent work by Pesaran, Shin, and Smith (1997), where they allow short run dynamics to vary across units but impose a constant relationship in the long run.

In spite of these caveats, the results in this paper are highly suggestive, especially when compared with those of Bond et al (1995) on investment and cash flow in U.K., Belgian, French, and German firms, which show much higher sensitivity of investment to cash flow in the U.K. than in the other three countries. Our work confirms a similar stylized fact for both investment and R&D, contrasting the cash flow sensitivity of U.S. firms with lack of the same in France and Japan. Given the gross similarity of the governance structures in the U.S. and U.K. and their differences from continental economies and Japan, our view is that the similarity of our results to those of Bond et al is not an accident: for whatever reason, either quicker responsiveness to market demand signals or higher costs of external capital, the Anglo-American environment is one in which there is a tighter correspondence between cash flow, profits, and sales on the one hand, and investment expenditures on the other.

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7 APPENDIX A: Bivariate Causality Regressions

TABLE A.1a

Does Cash Flow Cause Investment

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (174)	4 or 5	32.0 (5) **	9.9 (13)	111.3 (4) **
France (104)	5	5.9 (5)	11.8 (11)	12.6 (5) *
Japan (200)	4	34.6 (4) **	9.6 (13)	71.4 (4) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Investment)

	Without AB			With AB	
Country	Investment	Cash Flow	Lag	Investment	Cash Flow
US	-.110 (.057)	.333 (.107)	1	.183 (.033)	.434 (.046)
	-.287 (.031)	.158 (.040)	2	-.211 (.021)	.070 (.025)
	-.121 (.038)	.185 (.040)	3	.009 (.028)	.153 (.033)
	-.085 (.032)	.220 (.048)	4	-.093 (.018)	.168 (.025)
	-.085 (.023)	.090 (.037)	5	- -	- -
	-.688 (.144)	1.006 (.198)	Sum	-.111 (.074)	.825 (.086)
France	-.162 (.051)	.027 (.089)	1	.006 (.043)	-.011 (.053)
	-.309 (.037)	.024 (.028)	2	-.373 (.031)	-.009 (.033)
	-.185 (.028)	.049 (.024)	3	-.136 (.022)	.046 (.019)
	-.116 (.026)	.050 (.020)	4	-.062 (.026)	.032 (.025)
	-.081 (.025)	.032 (.020)	5	-.106 (.025)	.022 (.018)
	-.853 (.126)	.182 (.149)	Sum	-.607 (.053)	.081 (.099)
Japan	-.077 (.051)	.279 (.080)	1	.172 (.034)	.346 (.057)
	-.206 (.032)	.034 (.041)	2	-.097 (0.24)	-.025 (0.35)
	-.095 (.023)	-.017 (.037)	3	-.035 (0.20)	-.060 (0.33)
	-.088 (.020)	.178 (.038)	4	-.046 (0.19)	-.150 (0.32)
	-.467 (.104)	.474 (.124)	Sum	-.007 (0.66)	-.411 (0.75)

TABLE A.1b

Does Cash Flow Cause R&D?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (174)	4	1272.4 (4) **	8.6 (13)	235.2 (4) **
France (104)	3 or 4	18.7 (4) **	14.1 (15)	67.1 (3) **
Japan (200)	2 or 3	16.3 (3) **	26.1 (15) *	21.6 (2) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is R&D)

	Without AB			With AB	
Country	R&D	Cash Flow	Lag	R&D	Cash Flow
US	.216 (.049)	.182 (.022)	1	.304 (.060)	.240 (.020)
	-.057 (.019)	.083 (.012)	2	-.100 (.022)	.059 (.017)
	.042 (.013)	.058 (.010)	3	-054 (0.16)	.087 (.012)
	.023 (.012)	.094 (.010)	4	.111 (.049)	.158 (.016)
	.224 (.045)	.416 (.040)	Sum	.316 (.038)	.431 (.031)
France	-.141 (.034)	.089 (.016)	1	-.128 (.015)	.081 (.012)
	-.025 (.011)	.022 (.011)	2	-.013 (.005)	.025 (.007)
	.008 (.011)	-.004 (.008)	3	.016 (.005)	.018 (.005)
	.002 (.008)	.009 (.005)	4		
	-.126 (.054)	.125 (.037)	Sum	-.124 (.019)	.124 (.020)
Japan	.028 (.025)	-.022 (.037)	1	.216 (.017)	.055 (.025)
	-.035 (.014)	.058 (0.17)	2	-0.14 (.012)	.069 (.015)
	-.058 (0.12)	.005 (.017)	3		
			4		
	-.066 (.037)	.042 (.059)	Sum	.202 (.015)	.124 (.020)

TABLE A.2a

Does Investment Cause Cash Flow?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (174)	3	20.4 (3) **	9.8 (15)	40.7 (3) **
France (104)	5	19.2 (5) **	6.5 (11)	26.7 (5) **
Japan (200)	4	25.5 (4) **	30.1 (13) **	25.5 (4) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Cash Flow)

	Without AB			With AB	
Country	Cash Flow	Investment	Lag	Cash Flow	Investment
US	.067 (.038)	.008 (.028)	1	.203 (.030)	.005 (.023)
	-.091 (.017)	-.001 (0.14)	2	-.104 (.015)	.002 (.013)
	-.019 (.015)	.050 (.013)	3	.002 (.013)	.068 (.011)
	-.043 (.056)	.057 (.046)	Sum	.101 (.043)	.075 (.038)
France	-.275 (.054)	.010 (.024)	1	-.261 (.043)	-018 (.036)
	-.152 (.031)	.019 (.008)	2	-.117 (.025)	-.015 (.019)
	-.106 (.020)	-.012 (.005)	3	-.104 (.017)	.054 (.020)
	-.072 (.014)	-.035 (.016)	4	-0.77 (.012)	-.053 (0.14)
	-.065 (.013)	-0.26 (.011)	5	-.069 (.012)	-.030 (0.09)
	-.670 (.096)	-.044 (.090)	Sum	-.578 (.052)	-.170 (.080)
Japan	-0.57 (-.035)	-0.23 (0.25)	1	.050 (0.33)	-0.31 (0.25
	-.237 (.029)	.011 (0.12)	2	-.230 (.017)	-.003 (.013)
	-.082 (.018)	.013 (.012)	3	-.067 (.017)	-.013 (.011)
	.004 (.018)	.040 (.009)	4	.052 (.017)	0.31 (.009)
	-.372 (.054)	.039 (.049)	Sum	-.195 (.052)	-.015 (.049)

TABLE A.2b

Does R&D Cause Cash Flow?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (174)	3	49.5 (2) **	13.9 (13)	42.0 (3) **
France (104)	4	60.2 (4) **	12.2 (13)	116.9 (4) **
Japan (200)	3	25.6 (3) **	31.0 (15) **	32.5 (3) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Cash Flow)

	Without AB			With AB	
Country	Cash Flow	R&D	Lag	Cash Flow	R&D
US	-.154 (.029)	.137 (.068)	1	-.124 (.028)	.170 (.092)
	-.086 (.019)	.083 (.022)	2	-.075 (.017)	.092 (.020)
	-.033 (.013)	-.008 (.019)	3	-.037 (.010)	-.036 (.015)
			4		
	-.273 (.058)	.211 (.075)	Sum	-.235 (.046)	.226 (.060)
France	-.143 (.041)	.361 (.068)	1	-.103 (.032)	.416 (.049)
	-.161 (.018)	.047 (.023)	2	-.174 (.013)	.028 (.016)
	-.065 (.012)	-.023 (.022)	3	-.053 (.010)	-.020 (.014)
	.002 (.010)	-.091 (.017)	4	.029 (.009)	-.079 (.012)
	-.366 (.054)	.294 (.077)	Sum	-.303 (.050)	.345 (.053)
Japan	-.093 (.030)	-.023 (.020)	1	-.107 (.071)	-.014 (.016)
	-.201 (.017)	.050 (.010)	2	-.210 (.034)	.049 (.009)
	-.119 (.016)	-.003 (.009)	3	-.122 (.028)	.010 (.009)
			4		
	-.413 (.047)	.023 (.028)	Sum	-.438 (.042)	.044 (.023)

TABLE A.3a

Does Sales Cause Investment?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (204)	3	37.8 (3) **	12.8 (15)	84.8 (3) **
France (156)	4	7.2 (4)	7.7 (13)	6.6 (4)
Japan (221)	4	33.2 (4) **	13.9 (13)	77.6 (4) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Investment)

	Without AB			With AB	
Country	Investment	Sales	Lag	Investment	Sales
US	-.057 (.043)	.619 (.137)	1	.159 (.030)	.636 (.070)
	-.239 (.022)	.112 (.054)	2	-.141 (0.15)	-.648 (.047)
	-.072 (.018)	.013 (.043)	3	-.025 (.017)	.020 (.037)
	-.368 (.071)	743 (.136)	Sum	-.008 (.050)	.608 (.073)
France	-.010 (.060)	-.181 (.265)	1	.172 (.050)	-.093 (.215)
	-.230 (.032)	.056 (.085)	2	-.197 (.027)	-.065 (.077)
	-.129 (.024)	.135 (.065)	3	-.095 (.020)	.094 (.059)
	-.088 (.026)	-.124 (.073)	4	-.072 (.024)	-.117 (.066)
	-.458 (.119)	-.115 (.247)	Sum	-.192 (.099)	-.181 (.197)
Japan	-.184 (.059)	.392 (.222)	1	.053 (.044)	.430 (.149)
	-.211 (.034)	-.458 (.117)	2	-.111 (.026)	-.698 (.089)
	-.127 (.024)	.089 (.087)	3	-.055 (.021)	.196 (.079)
	-.080 (.020)	.308 (.083)	4	-0.70 (.020)	.243 (.083)
	-.603 (.033)	.330 (.229)	Sum	-.183 (.086)	.171 (.137)

TABLE A.3b

Does Sales Cause R&D?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (204)	4	86.4 (4) **	16.8 (13)	200.7 (4) **
France (156)	4	80.2 (4) **	18.2 (13)	133.0 (4) **
Japan (221)	3	25.1 (3) **	13.2 (15)	57.2 (3) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Investment)

	Without AB			With AB	
Country	R&D	Sales	Lag	R&D	Sales
US	-.081 (.042)	.233 (.067)	1	-.087 (.036)	.287 (.047)
	.001 (.011)	.111 (.023)	2	-.005 (.011)	.137 (.018)
	-.007 (.015)	.146 (.025)	3	-.003 (.012)	.108 (.021)
	.030 (.014)	.064 (.024)	4	.040 (.011)	.097 (.022)
	-.056 (.049)	.555 (.081)	Sum	-.055 (.053)	.628 (.053)
France	.081 (.047)	.313 (.089)	1	.188 (.041)	.352 (.075)
	-.049 (.014)	-.029 (.028)	2	-.060 (.012)	-.063 (.026)
	.011 (.012)	.069 (.024)	3	.038 (.010)	.063 (.020)
	-.019 (.017)	.178 (.020)	4	-.024 (.013)	.184 (.022)
	.024 (.059)	.531 (.087)	Sum	.142 (.053)	.536 (.071)
Japan	.042 (.024)	.224 (.106)	1	.179 (.017)	.290 (.060)
	-.047 (.013)	.083 (.040)	2	-.019 (.012)	.048 (.029)
	-.036 (.013)	.099 (.036)	3	.006 (.009)	.070 (.026)
			4		
	-.041 (.033)	.406 (.105)	Sum	.167 (.022)	.408 (.057)

TABLE A.4a

Does Investment Cause Sales?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (204)	5	23.0 (5) **	9.1 (11)	35.0 (5) **
France (156)	4 or 5	14.0 (4) **	20.0 (11) *	18.57 (5) **
Japan (221)	5	8.0 (5)	21.0 (11) *	23.0 (5) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Investment)

	Without AB			With AB	
Country	Sales	Investment	Lag	Sales	Investment
US	.236 (.049)	-.016 (.019)	1	.213 (.042)	-.026 (.019)
	.072 (.024)	-.028 (.011)	2	.124 (.023)	-.032 (.011)
	.040 (.022)	-0.15 (.011)	3	.078 (.021)	-.024 (.011)
	.098 (.020)	-.008 (.007)	4	.093 (.019)	-.010 (.007)
	.042 (.020)	-.028 (.008)	5	.054 (.019)	-.035 (.007)
	.488 (.067)	-.096 (.048)	Sum	.562 (.061)	-.127 (.047)
France	-.021 (.061)	.002 (.012)	1	-.070 (.069)	-.019 (.017)
	-.053 (.019)	.008 (.007)	2	.056 (.020)	.004 (.009)
	.020 (.015)	.008 (.005)	3	.072 (.017)	-.004 (.008)
	.061 (.021)	-.006 (.004)	4	.072 (.024)	-.008 (.007)
	- -	- -	5	-0.35 (.024)	-.013 (.005)
	.006 (.068)	.013 (.025)	Sum	-.016 (.077)	-0.39 (.040)
Japan	.074 (.069)	.009 (.013)	1	.017 (.064)	.011 (.012)
	-.104 (.034)	.001 (.009)	2	-.090 (.031)	-.006 (.009)
	.091 (.025)	.015 (.008)	3	.166 (.024)	.015 (.007)
	.134 (.026)	.005 (.008)	4	.126 (.026)	.003 (.007)
	.166 (.026)	.008 (.006)	5	.178 (.024)	.012 (.006)
	.362 (.066)	.038 (.039)	Sum	.398 (.060)	.035 (.036

TABLE A.4b

Does R&D Cause Sales?

Country	m	Causality w/o AB	Test for AB	Causality with AB
US (204)	4	27.2 (4) **	7.7 (13)	39.5 (4) **
France (156)	3	3.8 (3)	22.7 (15)	13.7 (3) **
Japan (221)	4	10.2 (4) *	13.0 (13)	38.0 (4) **

Chi-squared tests with degrees of freedom in parentheses. ** denotes significance at the 1% level and * at the 5% level.

Estimated Coefficients of the Lag Variables (Dep. Var. is Investment)

	Without AB			With AB	
Country	Sales	R&D	Lag	Sales	R&D
US	.161 (.048)	-.006 (.035)	1	.128 (.043)	-.023 (.034)
	-.064 (.018)	.047 (.011)	2	-.042 (.018)	.047 (.011)
	.012 (.020)	.022 (.011)	2	.040 (.019)	.036 (.010)
	.056 (.019)	.026 (.009)	4	.044 (.018)	.032 (.009)
	.165 (.064)	.089 (.046)	Sum	.170 (.062)	.092 (.045)
France	-.015 (.044)	-.019 (.024)	1	-.063 (.043)	-.060 (.024)
	.043 (.009)	.004 (.008)	2	.074 (.016)	-.007 (.006)
	.046 (.013)	.010 (.005)	3	.075 (.011)	.011 (.005)
			4		
	.073 (.054)	-.005 (.029)	Sum	.086 (.052)	-.056 (.028)
Japan	.473 (0.43)	-.003 (.015)	1	.679 (.036)	.009 (.012)
	-.122 (.026)	-.007 (.005)	2	-.163 (.026)	-.015 (.004)
	.040 (.023)	.006 (.004)	3	.075 (.025)	.018 (.005)
	.138 (.022)	-.013 (.007)	4	.113 (.018)	-.016 (.004)
	.533 (.040)	-.016 (.020)	Sum	.705 (.029)	-.004 (.016)