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Cyn-Young Park is an Economist at the Mekong Department of the Asian Development Bank. Jaejoon Woo is an Economist at the Organization for Economic Co-operation and Development (OECD). All errors are the authors' and the usual disclaimer applies to the Asian Development Bank and OECD. An earlier version of this paper was written while Cyn-young Park was an economist at OECD.

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Foreword

The ERD Working Paper Series is a forum for ongoing and recently completed research and policy studies undertaken in the Asian Development Bank or on its behalf. The Series is a quick-disseminating, informal publication meant to stimulate discussion and elicit feedback. Papers published under this Series could subsequently be revised for publication as articles in professional journals or chapters in books.

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Abstract

This paper investigates the effects of the ongoing changes in industrial structures arising from technology evolution and financial liberalization on the correlations of international equity markets. Results point to the greater influence of industry structures on the international co-movements of equity returns, largely driven by economic integration and recent technology spillovers. First, the correlation analyses find that the cross-country correlations have not only significantly increased, but the increases also seem to be more pronounced in the sectors that relate to the new economy. Second, based on a formal multifactor pricing model, the estimated risk exposure of the national industry index to the world industry and local market indices illustrates the growing importance of the world industry factors in the equity pricing relative to the national market. Third, emergence of industry-specific transmission in the telecom, media, and telecom sectors is indicated. The vector autoregression analyses, where a US shock of the industry-specific component is found to transmit more widely and effectively than that of the country-specific component within the TMT sectors, support the hypothesis that the new economy has become a new channel of financial transmission, at least among the G7 markets.

I. INTRODUCTION

In recent decades, the financial deregulation of domestic capital markets, the removal of legal and nonlegal barriers to capital flows, and improved access to information have substantially raised financial integration across capital markets in major industrialized countries. One important implication of financial integration is that national stock market returns will be increasingly influenced by global rather than domestic factors, since in a financially integrated market similar assets should display the same risk-adjusted returns. Indeed, stock market co-movements across borders have been well documented by numerous empirical studies.

The existing studies on the issue of integration can be broadly classified into two categories. The first strand of the literature tries to directly estimate international risk factors priced in the domestic asset returns, using international capital asset pricing models (ICAPM). Clearly, with increasing integration, international factors are expected to play a greater role in the pricing of national markets. The studies often report mixed results, providing no clear evidence of integration or segmentation. Some studies find evidence of time-varying integration (see, for example, Solnik [1974]; Stulz [1981]; Ferson and Harvey [1991]; and Bekaert and Harvey [1995, 1997]).

The second strand of the literature suggests that the degree of real economic integration is important in explaining equity market co-movements. The line of argument is that tighter trade linkages and greater capital mobility will lead to higher correlations of future dividend growth across countries and thus higher correlations of equity prices (for example, see Fama and French 1989 and Bracker et al. 1999). A related research interest also focuses on the increasing international spillovers and market contagion since the October 1987 stock market crash (see Bennett and Keleher 1988, Roll 1988, and Dwyer and Hafer 1988). These studies so far indicate that stock market correlations are significant and tend to increase over time, but that they vary substantially in degree depending on the geographical proximity and industrial composition similarity between countries.

Naturally, national markets with different industrial structures are exposed to different risks.[1] For example, a country with a high concentration of the manufacturing industry is more exposed to the risks concerning the world manufacturing industry, than another where the banking industry is more dominant. In this context, the effects of different industry mixes within national markets on international equity market correlations have long drawn attention from researchers and market practitioners. Heston and Rouwenhorst (1994) noted that imperfectly correlated industries might lead countries with different industry composition to be imperfectly correlated and that the benefits of international diversification could stem from industrial diversification.

[1] Roll (1992) finds that a technical aspect of index construction and the industrial structures of a country explain different behaviors of stock price indices across countries.

In their earlier paper in which they empirically estimated the industry- and country-specific effects in equity returns, however, they found that industrial structure explained very little of the cross-country correlation of equity returns for the sample period 1978-1992. But, factors that are specific to industrial sectors may have become relatively more important in the pricing of equity risk over the past decade along with increasing market integration. In effect, using the same method as in Heston and Rouwenhorst (1994), Tsatsaronis (2001) shows that the sectoral effects have become stronger for the euro area in more recent years. Tsatsaronis argues that synchronized macroeconomic conditions help shift gears from across countries to across industries in terms of portfolio diversification within Europe from a pan-European perspective.

However, there are no studies that address the issue of integration at the industry level or the comparison of the degree of integration across industries. A number of factors may have contributed to greater influence of industrywide integration in international correlations, yet in different degrees across industries. First, under the premise of the new economy, shocks mainly driven by the information and communication technology sector are likely to have more global impacts by reducing trading costs via online networks and information sharing.[2] Second, potentially greater earnings prospects in certain industry sectors, thanks to a positive productivity shock specific to those sectors, may have encouraged portfolio managers to seek geographical diversification of the same or related industries to minimize national variations in returns within the particular sectors. Third, to the extent that the international equity-market comovements are related to trade linkage, one can expect lower cross-country correlations in nontraded industries relative to traded industries.[3] Little has been, however, explored in the area of industrial structures for international correlations, leaving many questions unanswered as to effects of such changes on the co-movements and transmission of international equity markets.

The purpose of this paper is to examine the role of industrial structures on the international co-movements and transmission of equity returns for the G7 countries. First, this study will analyze the international correlations within industry groups to evaluate the degree of market integration over time. The industrial structures of international correlations shall provide a better understanding of market integration, by identifying the main drivers in the co-movements of equity returns. Second, given the increasing correlations, the question of particular interest will be the influence of international risk factors with respect to global industry developments on the pricing of a national industry index. Following the tradition of ICAPM, the risk sensitivity of each national industry group to the world industry and national market factors will be estimated over time and the comparative behaviors of these industry factors will be investigated. Lastly, the rise and fall of the so-called "new economy" sectors in the United States and its spillovers to other markets

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2 Obstfeld and Rogoff (2000) explain that home bias in equity portfolios is mainly due to trade costs. With the trade costs reduced, one can expect to see greater portfolio diversification across borders.

3 Obstfeld and Rogoff (1996, ch.5) show that under certain assumptions it is an equilibrium for all the claims to domestic nontraded industries to be held only by domestic residents, which implies that international portfolio diversification even in completely integrated world markets would be associated with high correlations in traded industries, but not necessarily in nontraded industries.

created anew an interest in how industry-specific shocks disseminate across national borders.[4] In this light, the possibility of industry-specific transmission will be explored in a formal vector autoregression (VAR) system in the telecom, media, and technology (TMT) sector.

This paper differs from previous studies in the following aspects. First, by focusing on the correlations of returns on national industry indices rather than those on market indices, this paper will uncover the real dynamics of international co-movements across different industries. Second, the estimation of market systemic risks will shed light on the relative importance of the world industry factor in equity pricing. Not only should the estimated international vis-à-vis national market factors point to the evidence of market integration among the G7 markets, but the varying effects of the world industry factors across different industry groups will provide insights for the role of the new economy in the co-movements of international equity markets. Third, a VAR framework will allow a more accurate picture of the dynamic transmission of the new economy and its effects on the international equity market co-movements. By decomposing a shock from two different sources (industry-specific versus country-specific), the channel of the new economy transmission will be closely analyzed. The empirical result will have implications for a new channel of global market transmission and contagion, if the industry-specific shock is found to become increasingly important relative to the country-specific shocks.

The sections of this paper are organized as follows. Section II considers the correlations of international equity markets within each industry component of the G7 markets over two time periods, 1973-1987 and 1988-2001. Section III employs two econometric methods to investigate the comparative behavior of the pricing factors that drive market co-movements and the transmission mechanism of a shock to the new economy. First, the time-varying betas will be estimated using a multifactor pricing model. Second, the transmission to other markets of a shock to the US market will be analyzed in a VAR framework. Conclusions follow in Section IV.

II. DATA DESCRIPTION AND CORRELATION ANALYSES

The data set analysed in this paper consists of monthly stock price indices of the G7 countries—Canada (CN), France (FR), Germany (BD), Italy (IT), Japan (JP), United Kingdom (UK), and United States (US)—for the period January 1973 to May 2001, which are all obtained from Thompson Financial Datastream. We follow the FTSE industry classification and examine ten industry groups for the G7 countries and the world: Resources, Basic industries, General industries, Cyclical consumer goods, Noncyclical consumer goods, Cyclical services, Noncyclical services, Utilities, Financials, and Information technology. Additionally, we also consider the TMT sector and local broad market indices. For the exercise of this paper, monthly excess returns have been

[4] A recent paper by Amato and Tsatsaronis (2001) asks whether a NASDAQ effect exists in emerging markets after accounting for the common global and sectoral components in the shock returns. The empirical results of the paper find that the correlation between returns on the NASDAQ and headline equity indices in emerging market economies is generally weak after accounting for industry composition effects.

obtained by subtracting one-month risk free interest rates proxied by local money market rates (and eurocurrency rates when they are not available) from monthly gross returns. Monthly gross returns are calculated as the first-log differences of the closing prices between the end-of-month trading days. In order to control for exchange rate fluctuations, the returns have been taken in local currencies (and for the four European countries, the returns are in euro).[5]

Table 1 presents the cross-country correlation coefficients of equity returns for the G7 countries in each of the ten industry groups, broader market, and TMT sector for the two time periods (1973-1987 and 1988-2001).[6] The coefficients have increased for most of the pairs of countries over two periods. In the broad market and the TMT sector, every pair of the G7 countries except one case (between Japan and the US) has seen an increase in the correlations. Although the correlations with Japan tend to remain relatively low, they also noticeably increased over time. Yet it is also true that the industrywide correlations vary across different industry groups: correlations in the nontraded goods sectors (such as Utilities) tend to be low whereas those for the traded goods (such as Basic industries and General industrials) are relatively higher. A closer look at the increases rather than the levels themselves also reveals that the sectors with greatest increases in the industrywide correlations seem to be related to the new economy. Indeed, other industry groups that are barely related to the new economy, such as Resources, Cyclical and Noncyclical consumer goods, and Utilities, do not register spectacular growth in the correlations.

Moreover, despite the steady upward time trend, the patterns of correlation dynamics seem to differ among three regional groups of G7 economies. The first group consists of Canada, UK, and US; the second, France, Germany, and Italy; while the last is Japan. Canada and the UK maintain the top two highest correlations with the US market in both periods, while correlations of the UK market with the rest of Europe increased substantially in the second period (for example, with Germany from 0.43 to 0.60, and with France from 0.51 to 0.64). The European stock markets have become highly correlated, as the broad market correlations of the French and Italian markets with the German market increased from 0.42 to 0.79 and from 0.28 to 0.63 respectively. The on-going economic integration among the European Union (EU) member countries as well as their geographic and cultural proximity must have contributed to the increased correlation between the European countries. The similar tendency across all industry groups in the EU area suggests that national market factors such as monetary and fiscal policies, and legal and institutional structures may have greatly assimilated at a regional level.

[5] A number of studies have documented the impact of foreign exchanges in various contexts. Although some studies find that foreign exchange risk affects the cross-country correlations of asset returns (Roll 1992, Bracker et al. 1999), their results are mostly inconclusive as to the direction of either correlation or integration of equity markets. Given the data availability of the exchange rates and further complication, this paper considers only raw returns in local currency. However, our main results remain mostly unchanged if we do the same exercises with the local asset in the US dollar term for the period where the exchange rates are available.

[6] The breakdown at the end of 1987 (which coincides with the well-known October crash) is based on the Chow test results for each series. For most of the series, the breakdown of 1987 seemed to be significant. Another structural breakdown was spotted around 1995, and the exercises of this paper have been in fact taken for the two subperiods (1988-1994 and 1995-2001) as well. The results from the latter two periods are not reported due to space limitations. However, they are largely consistent with the reported trend between 1973-1987 and 1988-2001.

Table 1. **Correlation Matrix of Monthly Returns for G7 Countries (1973-2001:5)**

	Germany	Canada	France	Italy	Japan	United Kingdom	United States
Resources							
Germany		**0.2566***	**0.2903***	**0.2677***	**0.1940**	**0.2316***	**0.1773**
Canada	0.3254		**0.4541***	**0.2281***	**0.2012**	**0.5328***	**0.6360***
France	0.2176	0.4004*		**0.4234***	**0.1546**	**0.5970***	**0.5575***
Italy	0.1504	0.2348	0.0645		**0.2789***	**0.3526***	**0.2417***
Japan	0.3116	0.0642	0.0906	0.4304		**0.2536***	**0.2804***
UK	0.3517	0.5420*	0.4938*	0.2041	0.0707		**0.6710***
US	0.4066	0.5968*	0.5263*	-0.0423	0.1082	0.6370*	
Basic Industries							
Germany		**0.4710***	**0.7199***	**0.4452***	**0.1989**	**0.5503***	**0.6070***
Canada	0.2516*		**0.5129***	**0.3375***	**0.2260***	**0.5364***	**0.7095***
France	0.3493*	0.4298*		**0.4884***	**0.2456***	**0.6230***	**0.5836***
Italy	0.2791*	0.3103*	0.3769*		**0.2628***	**0.4041***	**0.2584***
Japan	0.3224*	0.2431*	0.2402*	0.1748		**0.2862***	**0.2002**
UK	0.4741*	0.5088*	0.4441*	0.3545*	0.3382*		**0.6334***
US	0.3823*	0.7705*	0.4485*	0.2455*	0.3193*	0.5478*	
General Industrials							
Germany		**0.4821***	**0.6930***	**0.5623***	**0.3691***	**0.4899***	**0.5189***
Canada	0.2678*		**0.4748***	**0.3422***	**0.3315***	**0.4748***	**0.6673***
France	0.4064*	0.3736*		**0.5031***	**0.4040***	**0.5222***	**0.5536***
Italy	0.2467*	0.2480*	0.3414*		**0.4084***	**0.3760***	**0.2763***
Japan	0.4064*	0.3012*	0.1976*	0.1919		**0.3268***	**0.3554***
UK	0.3325*	0.4263*	0.3511*	0.3193*	0.3631*		**0.5174***
US	0.3177*	0.6457*	0.3212*	0.2157*	0.3552*	0.4787*	
Cyclical Consumer Goods							
Germany		**0.1746**	**0.6679***	**0.5818***	**0.3979***	**0.3827***	**0.5797***
Canada	0.1142		**0.2615***	**0.1828**	**0.1863**	**0.3570***	**0.3103***
France	0.2627*	0.2314*		**0.5102***	**0.3172***	**0.4362***	**0.5769***
Italy	0.1302	0.2607*	0.3884*		**0.3596***	**0.3815***	**0.3406***
Japan	0.3148*	0.1210	0.3289*	0.1882		**0.2323***	**0.2790***
UK	0.3750*	0.1955	0.4487*	0.2770*	0.3393*		**0.4743***
US	0.2912*	0.3120*	0.5132*	0.2087*	0.3924*	0.4226*	

(continued next page)

Table 1 (continued)

Noncyclical consumer goods							
Germany		**0.3518***	**0.5843***	**0.3966***	**0.2393***	**0.5292***	**0.4420***
Canada	0.3346*		**0.3723***	**0.2039***	**0.2361***	**0.4252***	**0.5447***
France	0.3651*	0.4776*		**0.3632***	**0.2561***	**0.5335***	**0.4567***
Italy	0.3541	0.3077	0.4639		**0.1539**	**0.2345***	**0.1267**
Japan	0.2949*	0.2300*	0.3474*	0.3124		**0.2244***	**0.2304***
UK	0.4016*	0.4473*	0.4432*	0.1707	0.4030*		**0.6171***
US	0.3793*	0.4841*	0.4039*	0.2427	0.3320*	0.4571*	
Cyclical Services							
Germany		**0.3155***	**0.5529***	**0.4672***	**0.2571***	**0.4497***	**0.3864***
Canada	0.3156*		**0.4020***	**0.4154***	**0.2712***	**0.4680***	**0.4911***
France	0.3840*	0.5200*		**0.5745***	**0.3525***	**0.5353***	**0.4444***
Italy	0.1556	0.1861	0.2226*		**0.2443***	**0.3859***	**0.2384***
Japan	0.2651*	0.1985*	0.2815*	0.1812		**0.3174***	**0.2164***
UK	0.3714*	0.4771*	0.4259*	0.3014*	0.2703*		**0.5204***
US	0.3722*	0.6398*	0.4393*	0.2172*	0.3163*	0.4853*	
Noncyclical Services							
Germany		**0.4467***	**0.5525***	**0.4716***	**0.2795***	**0.5640***	**0.3936***
Canada	0.1570		**0.3005***	**0.4233***	**0.2887***	**0.4198***	**0.4163***
France	0.2401*	0.3398*		**0.4021***	**0.3313***	**0.5343***	**0.3953***
Italy	0.2076*	0.1652	0.2343*		**0.3007***	**0.4130***	**0.2454***
Japan	0.1338	0.1161	0.0878	0.1903		**0.3058***	**0.3304***
UK	0.2923*	0.2503*	0.2696*	0.2053*	0.0934		**0.5219***
US	0.2159*	0.1686	0.3390*	0.1552	0.0771	0.2481*	
Utilities							
Germany		**0.2084***		**0.2357***	**0.1069**	**0.2279***	**0.1276**
Canada	0.1632			**0.0073**	**0.2267***	**0.2756***	**0.4219***
Italy	0.1535	0.0798			**0.1412**	**0.1905**	**0.1164**
Japan	0.1717	0.1104		0.0993		**0.1910**	**0.2867***
UK	0.1221	0.4309		0.3918	-0.2452		**0.2418***
US	0.2545*	0.5457*		0.0941	0.1233	0.0845	
Financials							
Germany		**0.5109***	**0.6478***	**0.5427***	**0.2432***	**0.5307***	**0.4158***
Canada	0.3208*		**0.4350***	**0.3473***	**0.3191***	**0.5058***	**0.6897***
France	0.4121*	0.3062*		**0.5542***	**0.2509***	**0.5616***	**0.3649***
Italy	0.2310*	0.2336*	0.2584*		**0.2474***	**0.4604***	**0.2329***
Japan	0.1505	0.1599	0.2103*	0.2728*		**0.3155***	**0.3494***
UK	0.3546*	0.3857*	0.2638*	0.3508*	0.2504*		**0.5858***
US	0.3537*	0.6013*	0.3583*	0.2505*	0.2532*	0.4444*	

(continued next page)

Table 1 (continued)

Information Technology							
Germany		**0.3524***	**0.4224***	**0.1061**	**0.3463***	**0.3888***	**0.3850***
Canada			**0.6430***	**0.2825***	**0.4638***	**0.5491***	**0.6591***
France		0.0648		**0.2876***	**0.4748***	**0.5646***	**0.4828***
Italy		0.3515	0.5383*		**0.2160***	**0.1700**	**0.1717**
Japan		0.1675	0.1670	0.3147		**0.4803***	**0.4562***
UK		0.0053	0.0968	0.4657		**0.3080***	**0.5330***
US		0.4682*	0.2803*	0.3627	0.2779*		**0.1732**
Broad Market							
Germany		**0.5761* (2.52)**	**0.7922* (4.51)**	**0.6277* (3.65)**	**0.3765* (0.26)**	**0.6014* (1.92)**	**0.5634* (1.49)**
Canada	0.3364*		**0.5637* (0.54)**	**0.4605* (1.67)**	**0.3890* (0.72)**	**0.6098* (0.56)**	**0.7671* (0.10)**
France	0.4156*	0.5136*		**0.6120* (1.96)**	**0.3977* (0.39)**	**0.6353* (1.41)**	**0.5642* (0.66)**
Italy	0.2808*	0.2936*	0.4303*		**0.3819* (0.75)**	**0.4792* (1.19)**	**0.3612* (1.06)**
Japan	0.3493*	0.3171*	0.3541*	0.3050*		**0.3868* (0.13)**	**0.3809* (-0.15)**
UK	0.4279*	0.5636*	0.5142*	0.3608*	0.3693*		**0.6803* (1.12)**
US	0.4236*	0.7519*	0.5088*	0.2458*	0.3864*	0.5930*	
Of which TMT sectors							
Germany		**0.5015* (3.22)**	**0.6897* (4.64)**	**0.5284* (3.30)**	**0.3736* (0.49)**	**0.6564* (2.91)**	**0.5737* (2.07)**
Canada	0.1761		**0.6209* (4.33)**	**0.5047* (3.50)**	**0.4568* (2.24)**	**0.6151* (3.74)**	**0.7177* (2.19)**
France	0.2785*	0.2133*		**0.5988* (3.74)**	**0.4433* (2.58)**	**0.6657* (3.99)**	**0.5442* (1.77)**
Italy	0.1996*	0.1524	0.2448*		**0.4391* (2.24)**	**0.4722* (2.53)**	**0.4058* (1.74)**
Japan	0.3319*	0.2327*	0.1756	0.2141*		**0.4100* (1.55)**	**0.4411* (1.51)**
UK	0.3965*	0.2617*	0.3140*	0.2230*	0.2487*		**0.6515* (1.95)**
US	0.3766*	0.5332*	0.3876*	0.2284*	0.2903*	0.4804*	

Note: The bold figures in the upper triangle report correlations in the latter period (1988-2001). For the correlations of the Broad market and the TMT sector returns, Z-statistics (in parenthesis) test the hypothesis that the correlations have remained the same over time.
* Indicates level of significance at the 1 percent level.

Although the correlation coefficients tend to increase and many of them are statistically significant, it is not to imply that the increase is statistically significant. To test the hypothesis that the correlation has changed over time for each bivariate relation, a test statistic has been devised. We first normalize the excess returns by dividing them by their standard deviations for each separate time period. The OLS estimate from a regression of one standardized series on another turns out to be equal to the bivariate correlation coefficient between the two series.[7] The test for a structural change in the correlation would then correspond to the test for the structural change in two OLS estimates between two time periods. Using these OLS estimates, we construct the following test statistics for the structural change in the correlation across different time periods:

$$Z = (b_1 - b_2)/\{V\hat{a}r[b_1] + V\hat{a}r[b_2]\}^{1/2}.$$

This Z-statistics is known to be approximately distributed as the standard normal (see Greene 1993, 167). Table 1 reports the estimates of the statistics in the parentheses for broad markets and the TMT sectors. The test results indicate that the increase in correlation among

7 This is so-called "z-score" transformation. $b = (\frac{X}{\sigma_X}'\frac{X}{\sigma_X})^{-1}\frac{X}{\sigma_X}'\frac{Y}{\sigma_Y} = Corr(X,Y)$

the Continental European countries (France, Germany, and Italy) is statistically significant. Considering the already high correlations, it is not surprising to see that those among Canada, UK, and US do not seem to have changed significantly. Noticeable changes were observed in the TMT sector where most of the increases have been statistically significant.

Cross-country correlations of equity markets reflect the combined effects of two distinctive factors: national market conditions and industrial structures. As earlier studies pointed out, two countries with sufficiently different industrial mixes will likely have lower equity market correlations, regardless of capital market integration (see Grinold, Rudd, and Stefek 1989; Roll 1992; and Heston and Rouwenhorst 1994). Although the correlations have generally increased for most industry groups as shown in Table 1, the extent to which they have increased seems to vary across different industry groups. Table 2 summarizes the variation and changes in the industrywide correlations of Table 1. It reports the simple averages and medians of the bilateral cross-country correlations and the correlations of the local industry with the world industry index for monthly returns. For two different time periods, the simple averages and medians are calculated from the bivariate correlation coefficients: (A) for each pair of the G7 countries and (B) between each national industry and the world industry group.

At first glance, both correlations have increased over time, but the correlations between the national and world industry index have been higher in both periods. It is interesting to note the comparatively different variation in the correlation evolutions of these correlation coefficients. The cross-country correlations (A) have increased in almost every industry with a notable exception of Noncyclical consumer goods that stayed the same, whereas the global industry correlations have increased relatively less and stayed rather constant (albeit at a relatively higher level). All else being equal, the greater increases in the cross-country correlations (A) can be largely attributed to assimilated national market conditions given that industry factors are controlled by constraining within specific industry groups. By and large, the country-specific variations seem to have diminished at least among the G7 economies, which supports the argument for the ongoing economic integration.

Another interesting finding is a striking distinction between the so-called new economy and the old economy in the patterns of correlation evolutions. Sectors that have been largely affected by the recent technology shocks and the new economy are the ones whose correlations have increased substantially more than other traditional ones. Information technology (from 0.27 to 0.40 in (A) and from 0.48 to 0.60 in (B)) and more generally the TMT sectors (from 0.28 to 0.54 in (A) and from 0.50 to 0.69 in (B)) have registered remarkable growth in cross-country correlations of returns. Financials has also substantially increased (from 0.31 to 0.43 in (A) and from 0.49 to 0.57 in (B)) perhaps due to deregulation and liberalization in this sector since the late 1980s. In the meantime, the old economy (Cyclical and Noncyclical consumer goods) and typical domestic industries such as Utilities remain relatively constant and low in correlations.

Table 2. **Average and Median of Correlation Coefficients of Monthly Returns (median in italics)**

	(A) Between National Industry Indices		(B) With the World Industry Index	
	1973-1987	1988-2001	1973-1987	1988-2001
Resources	0.29	0.35	0.53	0.57
	0.31	0.28	0.60	0.62
Basic Industries	0.37	0.44	0.58	0.56
	0.35	0.47	0.61	0.55
General Industrials	0.34	0.46	0.56	0.60
	0.33	0.46	0.61	0.59
Cyclical Consumer Goods	0.29	0.38	0.51	0.52
	0.29	0.36	0.48	0.53
Noncyclical Consumer Goods	0.36	0.36	0.55	0.54
	0.37	0.36	0.51	0.52
Cyclical Services	0.33	0.40	0.55	0.55
	0.32	0.40	0.57	0.53
Noncyclical Services	0.20	0.40	0.35	0.59
	0.21	0.40	0.32	0.58
Utilities	0.17	0.20	0.35	0.41
	0.12	0.21	0.40	0.38
Financials	0.31	0.43	0.49	0.57
	0.27	0.44	0.46	0.60
Information Technology	0.27	0.40	0.48	0.60
	0.28	0.42	0.45	0.61
Broad Market	**0.42**	**0.53**	**0.61**	**0.64**
	0.39	**0.56**	**0.63**	**0.66**
Of which TMT sectors	0.28	0.54	0.50	0.69
	0.25	0.53	0.50	0.70

Notes:
1 For Resources, Cyclical and Noncyclical consumer goods, and Utilities and Information Technology, some countries have a smaller number of observations in the first period (1973-1987). For Resources, Germany starts only from 1985 and Italy from 1986; for Cyclical consumer goods, Canada starts from 1977:3; for Noncyclical consumer goods, Italy starts from 1986; for Utility, UK starts from 1987 (France excluded, see below); for Information technology, Germany starts from 1988:12. Given that countries with shorter time series tend to have comparatively less internationally integrated financial markets and move rather independently of global trends, the correlation coefficients for these industries may be upwardly biased for the first period. Thus, the correlation analyses were done for the two subperiods (1988-2001 and 1995-2001) as well, since all the countries in the sample have the full time series at least from 1988 on. The time trend for the two subperiods matches with the result from the reported sample periods.
2 For Utilities, France is not included, as its series is only available from August 2000.

Many studies have confirmed that stock market correlations change over time.[8] The results in this section also evidence that the increase in international equity market correlations has been significant, suggesting the growing integration of world financial markets. Importantly, however, the degrees differ among the G7 countries. Not only do some countries such as the US manifest higher integration with the rest of the world than others like Italy and Japan, but the integration also seems to be rather contained within the regional boundary. In general, the correlations within traded sectors are also higher and have increased more than those in nontraded sectors, which is consistent with the predicted effects of market integration.[9]

Consistent with the observation that substantial integration has taken place industrywide through global supply chains and cross-listed stocks particularly of TMT sectors and Financials, the rise in correlations has been also significantly higher in those industries. The correlation analyses in each industry group hence suggest the increasingly important impacts of the industry-specific drivers on the correlation dynamics. On balance, the upward trend in the correlations of international equity markets seems to have benefited from the greater influence of the new economy sectors driven by technology advances and of globalization, as well as the lesser variation of country factors at least among the G7 economies.

III. ECONOMETRIC METHODS AND EMPIRICAL RESULTS

A. Estimating Industry and Country Factors by Betas

The results of correlation analyses support a compelling case where industry-specific risk factors may have become relatively more important in equity pricing, as global macroeconomic conditions co-move. The purpose of this section is to assess the comparative role of world industry factors in the pricing of national industry indices. By estimating multiple risk factors for the world industry and the national market over time, the empirical results will shed light on the driving factors for the recent equity market co-movements and possible transmission across borders.

According to the Capital Asset Pricing Model (CAPM), the pricing of assets relies only on the systemic risk relative to the market, which is often measured by the betas. While the traditional CAPM is focused on the single source of risk, asset pricing theory can be extended to incorporate multiple risk factors, by running a regression of the asset return at time t on various “factors” at time t. (Ross 1976, Roll and Ross 1980). The betas that are estimated in this manner are referred to as factor loadings, risk sensitivities, or risk exposures.

[8] See Erb et al. (1994) for the stochastic property of correlation measures in relation to business cycles and a survey of various studies on time-varying equity correlations.

[9] Obstfeld and Rogoff (1996) explain that portfolio diversification in a completely integrated world market will lead to higher correlations in traded goods sectors, but not necessarily in the nontraded goods sector.

Given the focus of this paper on industry vs. country factors, we have formulated a multiple regression to estimate the betas of the national industries with respect to the local market and world industry index, which is consistent with the previous CAPM literature.[10]

$$r_{ic} = \alpha + \beta_1 r_{iw} + \beta_2 r_{mc} + \varepsilon_{ic}, \qquad (1)$$

where r_{ic}, r_{iw}, and r_{mc} are excess returns on the national industry index, world industry index, and domestic market index, respectively.

Instead of using the world market index, we employed the world industry index, under the assumption that the risk exposure of a national industry to the world industry should involve that of the national industry to the world market as well. As it has been noted in the earlier literature, the returns on the national index are often positively correlated with those on the world industry index. In order to avoid the multicollinearity problem between two indices, (r_{iw} and r_{mc}), one can isolate the component, which is independent of each either, by projecting one on the other. That is:

$$r_{mc} = \mu_0 + \mu_1 r_{iw} + \eta_{mc}$$

The estimated $\hat{\eta}_{mc}$ is the domestic market component, which is not related to the world industry index. In a two-step regression procedure, one can use the orthogonalized component, i.e., the residuals from the simple regressions of r_{mc} on r_{iw} in order to estimate the risk sensitivity only to the national market component in the following equation.

$$r_{ic} = \gamma_0 + \gamma_1 r_{iw} + \gamma_2 \hat{\eta}_{mc} + \delta_{ic} \qquad (2)$$

One can show that the risk sensitivity only to the national market component, estimated by γ_2 in equation (2) is equal to β_2 in (1).

$$\begin{aligned} r_{ic} &= \gamma_0 + \gamma_1 r_{iw} + \gamma_2 \hat{\eta}_{mc} + \delta_{ic} \\ &= \gamma_0 + \gamma_1 r_{iw} + \gamma_2 (r_{mc} - \hat{\mu}_0 - \hat{\mu}_1 r_{iw}) + \delta_{ic} \\ &= \alpha + \beta_1 r_{iw} + \beta_2 r_{mc} + \varepsilon_{ic} \end{aligned}$$
$$where\ \alpha = \gamma_0 - \gamma_2 \hat{\mu}_0\ ,\ \beta_1 = (\gamma_1 - \gamma_2 \hat{\mu}_1)\ ,\ \beta_2 = \gamma_2\ and\ \varepsilon_{ic} = \delta_{ic}.$$

Similarly, the risk sensitivity only to the world industry component is equal to β_1 in (1). Hence β_1 and β_2 in (1) in effect represent the additional systemic risk relative only to the national market and world industry component, respectively.

Table 3 summarizes the betas for the world industry and national market by industry. Given the time-varying property of the betas,[11] the betas of all the industries are estimated for two separate periods (1973-1987 and 1988-2001) as well as an additional subperiod (1995-2001)

[10] Jorion and Schwartz (1986) formulated a multiple regression to estimate the betas to the national and world market index in an effort to test market integration versus segmentation.

[11] Ferson and Harvey (1991) examine a model in which multiple factors are priced with time-varying parameters, while Ferson and Harvey (1993) extend the dynamic factor model to an international setting. Harvey (1994) explores a similar formulation in emerging capital markets.

for a comparison. All the industry groups except for the industries of cyclical consumer goods and cyclical consumer services have recorded greater values of industry betas in the period 1988-2001. The increase in the industry betas is more pronounced in the latest 1995-2001 period, compared to the period 1973-1987. Most industries, on the other hand, have seen a decrease in the national market betas, with only the exception of the information technology industry. The estimated β_1 and β_2, however, measure the risk exposure to the additional information from the world industry and national markets respectively, for which a global technology shock that accompanies the structural changes in the local economy shall not be explained in terms of the industry factor. In other words, any technology shock that has idiosyncratically changed the national market condition is more likely to be captured in the local market beta, than in the world industry. This hypothesis is also consistent with the premise of the new economy that the real impact of the information and communication technology may lie on the market infrastructure, exerting an influence over the entire economy.

Table 3. **Industry and Domestic Market Betas by Industry Group**

	1973-1987		1988-2001		1995-2001	
	Beta	Std. Errors	Beta	Std. Errors	Beta	Std. Errors
Industry Betas						
Resources	0.41	0.04	0.59	0.03	0.74	0.04
Basic industries	0.17	0.02	0.26	0.02	0.55	0.04
General industrials	0.09	0.02	0.10	0.02	0.12	0.04
Cyclical consumer goods	0.30	0.05	0.21	0.04	0.28	0.06
Noncyclical consumer goods	0.24	0.02	0.40	0.02	0.55	0.04
Cyclical services	0.16	0.02	0.06	0.02	0.13	0.04
Noncyclical services	0.17	0.03	0.34	0.03	0.53	0.05
Utilities*	0.42	0.02	0.45	0.02	0.63	0.04
Financials	0.08	0.03	0.21	0.03	0.39	0.04
Information technology	0.29	0.02	0.44	0.02	0.47	0.04
TMT sectors	0.17	0.03	0.39	0.02	0.50	0.03
Domestic Market Betas						
Resources	0.62	0.04	0.45	0.03	0.27	0.04
Basic industries	0.90	0.02	0.81	0.02	0.54	0.04
General industrials	0.95	0.02	1.00	0.02	0.95	0.04
Cyclical consumer goods	0.87	0.05	0.87	0.04	0.78	0.06
Noncyclical consumer goods	0.71	0.02	0.57	0.02	0.40	0.03
Cyclical services	0.87	0.02	0.91	0.02	0.79	0.04
Noncyclical services	0.74	0.03	0.81	0.03	0.68	0.05
Utilities*	0.52	0.02	0.38	0.02	0.21	0.03
Financials	0.91	0.03	0.89	0.05	0.75	0.08
Information technology	0.65	0.02	0.82	0.02	0.93	0.04
TMT sectors	0.82	0.02	0.91	0.03	0.87	0.05

Note: The industry betas and country betas are calculated as simple averages of the betas of each individual G7 national industry index with respect to the world industry and national market indices, respectively, over the G7 countries for each industry group. Accordingly the standard errors are calculated as the square root of the sum of the estimated variances, divided by the number of countries.
* For Utilities, France is not included, as its series is only available from August 2000.

The different values of industry betas along with different degrees of cross-country, industrywide correlations have interesting implications. The relatively low industry betas (and the high national market betas) among the industries whose returns are highly correlated across borders may suggest that there is increasing synchronization in world business cycles. For example, Cyclical consumer goods and services are more likely to be affected by the national market factor (less by the world industry), and yet have been increasingly correlated across borders, which is supportive for the hypothesis of synchronizing domestic business cycles. In the opposite case of Utilities, it is puzzling that the industry with low cross-country correlation has relatively high industry and low national market beta. However, the highly regulated nature of the Utilities industry in many countries often prevents the prices from closely reflecting the domestic market condition, while the energy price may be largely vulnerable to a world industry shock.

Table 4 reports the average risk factors with respect to the world industry and national market for each country. For all the countries in the sample except Japan, the betas are higher to the world industry and lower to the local market. The result is consistent with the previous literature on the growing integration of the world financial markets at least among the G7 countries. It is also not surprising that the US market has by far the highest global industry beta and the lowest domestic market beta in all periods. For the US, the industry beta increased from 0.52 to 0.86 while the domestic market beta decreased from 0.59 to 0.21 from the first period (1973-1987) to the last period (1995-2001).

Table 4. **Industry and Domestic Market Betas by Country**

	1973-1987		1988-2001		1995-2001	
	Beta	Std. Errors	Beta	Std. Errors	Beta	Std. Errors
Industry Betas						
Canada	0.17	0.03	0.30	0.03	0.42	0.04
France	0.11	0.04	0.26	0.03	0.40	0.05
Germany	0.10	0.03	0.20	0.02	0.36	0.04
Italy	0.06	0.03	0.12	0.03	0.23	0.05
Japan	0.38	0.03	0.41	0.03	0.29	0.04
UK	0.13	0.03	0.31	0.02	0.47	0.04
US	0.52	0.02	0.49	0.02	0.86	0.03
Domestic Market Betas						
Canada	0.80	0.03	0.66	0.03	0.54	0.04
France	0.89	0.04	0.87	0.04	0.78	0.05
Germany	0.84	0.02	0.75	0.02	0.67	0.04
Italy	0.91	0.02	0.93	0.02	0.84	0.03
Japan	0.64	0.03	0.75	0.02	0.74	0.03
UK	0.89	0.02	0.80	0.03	0.62	0.06
US	0.59	0.02	0.53	0.02	0.21	0.03

Note: The industry betas and country betas are calculated as simple averages of the betas of each individual G7 national industry index with respect to the world industry and national market indices over the ten industry groups for each country. Accordingly the standard errors are calculated as the square root of the sum of the estimated variances, divided by the number of industries.

In line with the results of the correlation analyses, the estimated betas confirm increasing market integration by illustrating the growing influence of international factors over national factors in equity pricing. For most industry groups as well as for all the G7 countries, the world industry factors have markedly increased over time. On balance, however, national market factors still seem to play a non-negligible role in equity pricing, despite the significantly increased effects of the world industry factor.

B. Industry-specific Transmission of Shocks

To investigate the dynamic transmission of industry shocks across borders, we estimate the following VAR model with two-month lags in each country variable for each industry *i*.

$$RET_{it} = B_{i0} + B_{i1} RET_{it-1} + B_{i2} RET_{it-2} + E_{it} \,, \tag{3}$$

where RET_{it} is a 7×1 vector of excess returns in industry *i* for the seven countries in our sample, B_{i0}, B_{i1}, and B_{i2} are matrices of coefficients to be estimated, and E_{it} is a vector of error terms.

To the extent that the global industry factors are pertinent to the pricing of the national equity market, a channel of international transmission has been likely transformed into an industry-specific one. One of the key questions that we can address using the VAR is whether a shock in a national market is useful for forecasting returns on the other markets. Another related issue is whether or not a shock from the new economy sectors has transmitted more globally via this new channel of industry-specific transmission.

Given the sensitivity of a VAR system to its ordering, the Granger causality test (Granger 1969) has been taken to help discern the direction in which innovations of an industry transmit from one particular market to others.[13] The bilateral results from the Granger tests have an advantage of not being affected by a specific order. Based on the test results, the VAR system is thus ordered as follows: US, Canada, UK, France, Germany, Italy, and Japan.

The recent rise and fall of high-technology stocks seems to highlight an emergence of an industry-specific transmission of financial disturbance. A large number of existing empirical studies on international contagion and spillovers found that the US market returns influenced the returns

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[12] The number of lags was chosen based on three tests: the Likelihood Ratio test (Sims 1972), and the Information Criteria tests by Akaike (1973) and Schwarz (1978). Each series of monthly returns was tested for the presence of a unit root using two alternative tests suggested by Dickey and Fuller (1979) and Phillips and Perron (1988). All these tests rejected the assumption of a unit root for all time series considered, implying that the variables are stationary. For more about these tests and the references, see Hamilton (1994).

[13] The Granger test results indicate the bilateral usefulness of returns on one market for forecasting one-period-ahead returns on the other market. The US market is found by far the most influential, with its clear lead in many industry groups. The increased integration with the US market seems to have increased the explanatory power of returns of the Canadian and UK markets for future expected returns of other markets as well. Surprisingly, France rather then Germany is more effective in terms of forecasting other European markets. It is perhaps because Germany is comparatively more dependent on the US market.

on other markets. King and Wadhwani (1990) and Lin et al. (1994) argue that investors extract only the relevant information from observed price changes in the foreign markets when pricing the domestic assets. As supply chains of the new economy sectors globalize and recent information and communication technology advances pass through international networks, the innovation of these sectors may have more global repercussions through signal extraction of industry-specific information.

In this context, a shock to a US industry has ripple effects on the rest of the world, via two distinct but related channels. First, the industry-specific component of the new information will have an impact on the same industry worldwide. To the extent that a shock changes future earnings prospects of the particular industry in question globally, other national markets will incorporate the new information in their pricing of the same industry. Second, the market component of the innovation will transmit to other markets. Since the shock is likely to change the related profits and thus economic conditions of the domestic market as well, the information is relevant for all the trading and investment partners of the US. For example, when Intel introduces a new processor, the information would not only affect the global information technology sector directly, but also increase US earnings and thus demand for French wine indirectly.

As is shown in the previous section, the returns on a national industry can be decomposed into three different components:

$$r_{\text{ic}} = \hat{\alpha} + \hat{\beta}_1 r_{\text{iw}} + \hat{\beta}_2 r_{\text{mc}} \,,$$

where $\hat{\alpha}$ is the idiosyncratic national industry component, $\hat{\beta}_1 r_{\text{iw}}$ the world industry, and $\hat{\beta}_2 r_{\text{mc}}$ the national market.

We separately investigate impacts of a shock from the world industry component and from the national market component by constructing the VAR systems as follows: (A) the world industry component of the US industry returns $\left(\hat{\beta}_1 r_{\text{iw}}\right)$ with the rest of the national industry returns on Canada, UK, France, Germany, Italy, and Japan; and (B) the national market component of the US industry returns $\left(\hat{\beta}_2 r_{mc}\right)$ with the rest of national industry returns (Canada, UK, France, Germany, Italy, and Japan). A shock of one standard deviation is introduced in the US market and its dynamic effects are traced throughout the system for the next year. The confidence bands are also presented using asymptotic distributions. The effects of a shock originating from either the US industry or the US market component of G7 countries are quite significant. Most of the shocks taper off after one month or at the most two, which is consistent with the efficient market hypothesis.

The evidence shows that innovations in the TMT sector have become more influential recently. It should be also noted that the impulse responses to industry shock have been stronger than to market shock. The finding that the impact of industry shock is greater than that of market implies that a shock to the TMT sector has quite a strong industry-specific influence on G7 economies, aside from indirect effects on the US market. Since an innovation from the US industry would affect the local market performance in the other G7 markets, the impulse response functions of each national industry would also reflect the general reaction to the market component of a shock as well. Thus, only the additional effects of the industry shock over the national market shock may be considered as the industry-specific transmission, which seems to be quite significant in the TMT sector. In fact, this is rather TMT-sector special, since the similar impulse response functions in other industry groups did not differ widely between the industry shock and the market shock.

IV. CONCLUSION

The key focus of this paper was to analyze whether and to what extent ongoing changes in industrial structures along with advances in information technology and financial liberalization have an impact on the correlations and co-movements of international equity markets.

In an effort to investigate financial integration at the industry level, the paper first examined the cross-country correlations for the G7 countries in different industry groups. The results indicated that the cross-country correlations have not only significantly increased, but the increases also seem to be more pronounced in the sectors related to the new economy. Diminishing variation of national market conditions particularly for the neighboring countries and the global impact of the new economy have surfaced as the most relevant factors in increasing international co-movements. Secondly, a formal multifactor pricing model was employed to estimate the risk exposure of the national industry index to the world industry and national market factors. In support of the correlation analyses (which imply both less differential national economic conditions and more influential global industry effects), the estimated betas clearly suggest that the world industry factors have become increasingly important in the pricing of national industry indices. The third finding of this paper is the emergence of industry-specific transmission in the TMT sector. The VAR system of the G7 equity returns allows a comparison between responses of the G7 markets to a shock of the domestic market and to the global industry component of the TMT sector. The results support that the industry-specific transmission channel has become more important in the TMT sector in recent years.

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