

# International Investing: Managing Multiple Layers of Alpha

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## Abstract

*Frequently investors have much more information than they can possibly digest. Developing and employing efficient information processing machinery to handle large amounts of data in a consistent way is the key to success in this environment. In this article we argue that it is critical for international equity asset managers to organize information according to its scope. The structure outlined here categorizes information into three types--global, local, and asset-specific. While we confine ourselves to these three types for illustration purposes, the model is readily expandable to other types of information. Other asset classes can be introduced as well.*

## Introduction

Today's investors command a vast amount of technical and fundamental data and third-party research. Information sources have become increasingly disparate via the proliferation of channels even as they have become increasingly linked through financial market integration. Successful managers are able to isolate and exploit information in the most effective way, neither double counting nor losing it. Limited resources make this task far from simple.

Financial researchers and practitioners have dealt with the complexity of modern investing by using models based on broad factors that span markets. Factor models boil down market complexity into a parsimonious set of factors, representing commonalities in the behavior of individual assets grouped by their characteristics. Well-built factor models can be used to organize complicated ex ante investment decision-making processes as well as to facilitate a systematic approach to analyzing ex post performance.

Traditional global equity factor models (see Grinold et al. (1989) and Heston and Rouwenhorst (1994, 1995)) attribute an asset's returns to country, global industry and global style factors. Many empirical studies have since followed, examining the relative importance of these factors and its implications for the hierarchy of portfolio allocation decisions and the best use of analyst resources. While the early work of Grinold et al (1989)<sup>1</sup> found country selection to be the dominant decision, later empirical studies found the dominance of country factors to wane in the late 1990s.<sup>2</sup> The debate continues over whether the increasing importance of global industries in that period was due to a transitory bubble in the technology sector or is symptomatic of a long-

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<sup>1</sup> See also the subsequent studies of Heston and Rouwenhorst (1994), Rouwenhorst (1999), and Griffin and Karolyi (1998).

<sup>2</sup> See Baca et al (2000), Cavaglia et al (2000, 2002), Hamelink et al (2001), L'Her et al (2002), Scowcroft and Sefton (2002), Brooks and Del Negro (2002), Kritzman and Page (2003), Puchkov, Stefek, and Davis (2005).

term structural shift. Current evidence suggests that country and industry factors are now at compatible levels (Puchkov and Nielsen, 2005).

Given the gradual shifts in factor hierarchy, multi-layered factor models have been proposed as a more robust alternative to traditional global factor models for global equity management. In a multi-layered factor model, commonalities in asset returns can be represented by country-industry groupings, such as “U.S. Pharmaceuticals” or “U.S. Large Cap.” Puchkov, Stefek and Davis (2005) demonstrate that these country-industry groupings have in fact become more important, particularly in developed markets. In this situation the main strengths of a traditional global model—parsimony—become its weaknesses. Traditional global models fail to capture the full complexity and granularity of modern global markets.

Along the same lines, this increase in complexity has implications for how international equity managers categorize and interpret their information. Somewhat ironically, global integration has made the problem of international investment more fragmented. Consider a similar analogy dealing with the effects of global warming on commercial sailing in polar waters. Rising temperatures are causing large floating ice fields to break apart into smaller pieces. The good news is that there are less Titanic-sized icebergs capable of sinking a ship. The bad news is that there are many smaller pieces that can slow down the ship. Sailors who don't do a good job avoiding floating ice put themselves in a position of competitive disadvantage which, while much better than being in a position of mortal danger, is not good for their business. Since there are a lot more small pieces of ice to avoid than there used to be, the problem of commercial navigating becomes harder!

The goal of this article is to present a formal and transparent way to combine information utilizing a multi-layered factor approach. The multi-factor structure is based on that of the Barra Integrated Model which decomposes asset returns into three different layers: (1) returns attributable to either the asset's market (country) or global industry/style (“global component”); (2) returns attributable to country-specific industry and style influences (“purely local component”);<sup>3</sup> and (3) stock-specific returns. (Appendix A gives further details of this risk model.) While for the sake of simplicity we concentrate on equities, a similar approach can be used for other asset classes.

## Managing Multiple Sources of Information: The Challenge

One of the greatest challenges for international equity managers is combining separate pieces of information from different and not necessarily consistent sources. In a top-down or bottom-up approach, if the information in each layer is not separable, then loss of efficiency may arise. For instance, a top-down manager making a country allocation decision first and subsequently making an industry allocation decision in each country may find it difficult to incorporate a view on

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<sup>3</sup> The purely local industry component of returns captures the part of returns that cannot be explained by inter-market factors (countries, global industries and global styles). For example, consider two factors in BIM—the U.S. banking factor, which captures the co-movement of U.S. bank returns, and the Japan banking factor, which captures the same for Japanese bank stocks. These two factors are shaped by the influences of countries, global industries and global styles. For example, the U.S. banking industry is influenced by the performance of the U.S. market and of the global banking industry. However, the U.S. banking factor also has a component that is independent of these, one which does not move in lockstep with the U.S. market and global financial sector. The impact of governmental regulation, the state of domestic economies and interest rates, and local investor behavior can all shape these purely local returns.

a particular global industry. Likewise, a bottom-up manager focused on stock selection may have a hard time incorporating any industry or country views.

For example, imagine the following opinions are received from four independent analysts:

1. The U.S. market will have stellar performance while the German market will slightly lag;
2. The global pharmaceutical industry will have good performance while the global financial industry will significantly lag;
3. The German financial sector should have a neutral performance whereas U.S. pharmaceuticals will likely under-perform;
4. The performance of Merck will be on par with Deutsche Bank.

If we assume the first two opinions are independent, the issue of consistency does not arise. However, the third forecast is somewhat at odds with the first two. In fact, for all three to be consistent the third opinion must be based solely on information related to local industry which is independent of the worldwide industry or market outlooks. Finally, the fourth forecast also appears at first glance to be at odds with the first three. For all four to be consistent, this forecast should be driven in part by the company-specific information.

What challenge does the manager face if he tries to incorporate the four analyst opinions above? Table 1 summarizes the four different recommendations as scores. (These scores can be thought of as the buy/sell/hold recommendations of these analysts.)

**Table 1: Scores for Analyst Forecasts**

<b>Analyst Forecast 1</b>	
<b>U.S.</b>	<b>+2</b>
<b>Germany</b>	<b>-1</b>
<b>Analyst Forecast 2</b>	
<b>Pharmaceuticals</b>	<b>+1</b>
<b>Financials</b>	<b>-2</b>
<b>Analyst Forecast 3</b>	
<b>U.S. Pharmaceuticals</b>	<b>-1</b>
<b>German Financials</b>	<b>0</b>
<b>Analyst Forecast 4</b>	
<b>Merck</b>	<b>0</b>
<b>Deutsche Bank</b>	<b>0</b>

For now, we assume that the analyst forecasts are weighted equally though later we discuss how the manager can vary his weights based on his confidence about the information or his risk aversion.

Suppose our manager is a traditional top-down manager who allocates first along country lines. First he incorporates Analyst Forecast 1; he overweights the U.S. and underweights Germany giving a score of +2 to the U.S. and -1 to Germany as in Table 1.<sup>4</sup> Now the manager can incorporate Analyst Forecast 2 or Analyst Forecast 3 but **not both** simultaneously. Why is this the case? Suppose the manager incorporates Analyst Forecast 3 with Analyst Forecast 1 (ignoring Analyst Forecast 2), then he sums the corresponding scores as follows:

**Table 2: The Challenge of Integrating Disparate Information: Countries First Illustration (Example 1)**

		Pharmaceuticals	Financials
U.S.	2	$2 - 1 = 1$	2
Germany	-1	-1	$-1 + 0 = -1$
Total		0	1

Unfortunately, the global pharmaceutical sector (which is equal to the sum of U.S. and German pharmaceuticals) is expected to under-perform global financials, contradicting Analyst Forecast 2.

What if the manager first incorporates Analyst Forecast 2 instead?

**Table 3: The Challenge of Integrating Disparate Information: Countries First Illustration (Example 2)**

		Pharmaceuticals	Financials
		1	-2
U.S.	2	$2 + 1 = 3$	$2 - 2 = 0$
Germany	-1	$-1 + 1 = 0$	$-1 - 2 = -3$

Now the resulting global industry forecast contradicts Analyst Forecast 3 which predicts German financials outperforming U.S. pharmaceuticals.

This example highlights the challenges of investors managing multiple sources of information. Similar examples can be built where managers select global industries first and then countries, just to arrive at a perplexing disagreement with the local information of Analyst Forecast 3. As the number of signals multiplies, incorporating them can quickly become confusing. We now turn to the layered framework to show how this can be done in a more structured way.

<sup>4</sup> While managers typically allocate weights, we allocate scores in this example for ease of interpretation.

## Managing Multiple Sources of Information: The Solution

Categorizing information helps a manager ensure consistency. If the manager knows that the third analyst's forecast comes from an analysis of local sources then it may be consistent with the first two forecasts. However, if it comes from an analysis of market and global industry information, it is likely inconsistent and some forecasts must be discarded or down-weighted. Organizing information in a tractable way helps to keep the data modular, making it easier to assess the impact of a particular piece of information on the overall strategy.

Let's continue our stylized example which we now extend to German, U.S., and U.K. stocks across three industries—pharmaceuticals, telecom, and financials. Similar to returns themselves, we break down information along the three dimensions in the Barra Integrated Model. Recall that in BIM, returns can be decomposed into three components, corresponding to the global component of stock returns, purely local component of stock returns, and stock-specific return. Similarly, we define information associated with each layer as *global-relative*, *local-relative*, and *asset-relative*, respectively. The first layer, global-relative, is information that pertains to inter-market factors (countries and global industries and styles). The second layer, local-relative, reflects information for a particular industry in a particular country. The third layer, asset-relative, describes information specific to an individual stock.

Applying this structure to the information in the example, we categorize Analyst Forecasts 1 and 2 as global-relative views. They reflect outlooks for the pharmaceutical and financial industries across many countries as well as outlooks for all U.S. and German assets. Rankings for countries and industries should be independent of each other. If they are, then scores can be combined linearly.

Analyst Forecast 3 is an example of local-relative information. This information has a much more limited impact as it likely impacts only a handful of local industries. Analyst Forecast 4 has the least scope and is an example of asset-relative information. It impacts only the two named assets, Merck and Deutsche Bank.

We categorize the scores we used in the previous example below.<sup>5</sup>

1. The U.S. market will have stellar performance while the German market will slightly lag;
2. The global pharmaceutical industry will have good performance while the global financial industry will significantly lag;

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<sup>5</sup> We have added the U.K. and Telecommunications as a third country and industry in this example which is necessary for illustrating how to ensure consistency via the layered approach.

**Table 4: Scores for Countries and Global Industries (Global-Relative Layer)**

<b>Layer 1: Global Relative</b>	
<b>Analyst Forecast 1 (Country)</b>	
U.S.	+2
Germany	-1
U.K.	0
<b>Analyst Forecast 2 (Global Industry)</b>	
Pharmaceuticals	+1
Financials	-2
Telecom	0

- The German financial sector should have a neutral performance whereas U.S. pharmaceuticals will likely under-perform;

**Table 5: Local Industry Scores (Local-Relative Layer)**

<b>Layer 2: Local Relative</b>	
<b>Analyst Forecast 3 (Local Industry)</b>	
U.S. Pharmaceuticals	-1
German Financials	0

- The performance of Merck will be on par with Deutsche Bank.

**Table 6: Stock-Specific Scores (Asset-Relative Layer)**

<b>Layer 3: Asset Relative</b>	
<b>Analyst Forecast 4 (Stock Specific)</b>	
Merck	0
Deutsche Bank	0

Let's start by linearly combining country and industry scores into a global-relative allocation matrix. We can do this because we assume country and global industry information are

independent. In this case, the score for U.S. pharmaceuticals is just the sum of the scores for the U.S. and global pharmaceuticals.

**Table 7: Global-Relative Allocation Matrix**

		Pharmaceuticals	Financials	Telecom	Total
	Rank	1	-2	0	
<b>U.S.</b>	<b>2</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>5</b>
<b>Germany</b>	<b>-1</b>	<b>0</b>	<b>-3</b>	<b>-1</b>	<b>-4</b>
<b>U.K.</b>	<b>0</b>	<b>1</b>	<b>-2</b>	<b>0</b>	<b>-1</b>
		4	-5	1	

Combining the first two forecasts worsens the aggregate view for German financials and brightens the aggregate view for U.S. pharmaceuticals. However, as we saw already, this result conflicts with Analyst Forecast 3 which predicts that U.S. pharmaceuticals will likely underperform German financials. How do we incorporate Analyst Forecast 3?

To be consistent with our global outlook this opinion must be based on local industry information that is not related to the overall country and global industry outlooks. If indeed these purely local factors are cross-sectionally independent from the country and global industry factors, then including them in our forecast will not modify the scores shown in Table 7.

The way we do this is to create an identical overlay table to organize our local-relative pieces of information. Each individual cell in the table starts with a base information-less value of zero and corresponds to a local industry. Industry and country dimensions are tied by the global selections in Table 7 and are no longer independent from each other so we have to account for this. What we need to do is adjust the scores so that U.S. pharmaceuticals underperforms German financials but in such a way that the sum of each column and sum of each row remains zero. That way the net exposure to each country and each global industry will remain unchanged. Although a multitude of scenarios are possible, for illustration, we will describe one possible adjustment.

First, we create an identical overlay to the global-relative allocation matrix that has the same countries and industries in the corresponding cells. We start with a base value of zero and as long as the sum of each column and the sum of each row remains zero, we can later overlay this local-relative allocation matrix on the global-relative matrix while preserving information consistency. That is, we need only to preserve the net exposure to the countries and industries at the global level.

Let's start with the following local-relative scores:

**Table 8: Local Relative Allocation Matrix**

	Pharmaceuticals	Financials	Telecom
<b>U.S.</b>	<b>-7</b>	<b>0</b>	<b>+7</b>
<b>Germany</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>U.K.</b>	<b>+7</b>	<b>0</b>	<b>-7</b>

We call this a “quadruple” since there are four terms which result in the sum of rows/columns zeroing out. Here we have incorporated Analyst 3’s view that U.S. pharmaceuticals will underperform German financials by adjusting our forecasts for U.K. pharmaceuticals, U.S. telecom, and U.K. telecom. We have offset local industries in different cells against each other by taking a compensatory position in another pair of industries. Thus, in order for some sectors to gain something else has to give, a requirement which we will have more to say about later.

If we overlay Table 8 on Table 7, we get the following matrix:

**Table 9: Combined Global-Relative and Local-Relative Allocation Matrix**

		Pharmaceuticals	Financials	Telecom	Country Totals
	Rank	1	-2	0	
<b>U.S.</b>	<b>2</b>	<b>3 - 7 = -4</b>	<b>0 + 0 = 0</b>	<b>2 + 7 = 9</b>	<b>5</b>
<b>Germany</b>	<b>-1</b>	<b>0 + 0 = 0</b>	<b>-3 + 0 = -3</b>	<b>-1 + 0 = -1</b>	<b>-4</b>
<b>U.K.</b>	<b>0</b>	<b>1 + 7 = 8</b>	<b>-2 + 0 = -2</b>	<b>0 - 7 = -7</b>	<b>-1</b>
<b>Industry Totals</b>		<b>4</b>	<b>-5</b>	<b>1</b>	

The matrix in Table 9 now meets all the criteria in Analyst Forecasts 1 thru 3. Global pharmaceuticals will outperform financials; and the U.S. will outperform Germany. Meanwhile, U.S. pharmaceuticals will underperform German financials.

Of all the possible solutions, how do we identify the best possible combination of scores that meets all criteria? Critical to our example is that we have assumed that all our adjustments to the U.K. and telecom scores have been consistent with the manager’s views. In fact one of the key benefits of a structural approach to information processing is that it forces a better understanding of all positions in the portfolio, even those which the manager has no explicit information about. In this stylized example, we have for instance “uncovered” information about several other sectors--significant out-performance of U.S. Telecom at the expense of U.K. and German Telecom. In contrast if we did in fact have views on these country-sector groupings which were not consistent with the results so far, we would need to layer additional quadruples until all criteria were satisfied. Multiple quadruples can be layered to create quite intricate combinations (an example is shown in Appendix B).

In the absence of information about other positions in the portfolio (that is, if the information is asymmetrical, specifying only one vertex of a quadruple, e.g. U.S. Pharmaceuticals will not do well), compensatory positions can be equally distributed among all positions. For example, local underperformance of U.S. Pharmaceuticals can be distributed over all countries in the Pharmaceuticals sector and all sectors in the U.S., as shown in Table 10. To take it one step further, we might want to distribute the positions in such a way as to minimize the changes in scores (“score deltas”) while still satisfying all the necessary criteria.

**Table 10: Local Underperformance of U.S. Pharmaceuticals Distributed Over All Sectors and Countries**

	Pharmaceuticals	Financials	Telecom	Total
U.S.	-7	3.5	3.5	0
Germany	3.5	-1.75	-1.75	0
U.K.	3.5	-1.75	-1.75	0
Total	0	0	0	

Our last step is to assign scores to individual assets based on the asset-specific information. Specifically, we want to include Analyst Forecast 4 which predicts that Merck's performance will be on par with Deutsche Bank's. Again, we start out with a matrix of zeros. Any stock-specific adjustments must not alter the global or local industry views and should therefore sum to zero inside each industry cell. Our task is to set asset-specific signals for Merck and Deutsche Bank along with compensating adjustments within each country-industry cell.<sup>6</sup>

One possibility, using Pfizer and Dresdner for example, is depicted in Table 11 below.

**Table 11: Stock-Specific Allocation Matrix**

	Pharmaceuticals		Financials		Telecom	Total
U.S.	Merck = 1	Pfizer = -1	0		0	0
Germany	0		Deutsche = 0	Dresdner = 0	0	0
U.K.	0		0		0	0
	0		0		0	

Again, in the process of reconciling asset-specific information we have uncovered a negative asset-specific forecast for other firms in our U.S. pharmaceuticals portfolio (in this example, Pfizer). Note that because neutral performance of Deutsche Bank already follows from Table 11, we do not have to make any adjustments for it.

Finally, we construct a total score combining all three layers: global-relative, local-relative, and asset-relative. If we equal weight all sources of information, we obtain the final result in Table 12 by summing up the scores from Table 9 and Table 11. (Note that the **average** score across the two firms in each cell equals the value originally in the cell in Table 9.)

<sup>6</sup> If sectors are defined on a cap-weighted basis, an appropriate weighting scheme should be used in setting asset-specific forecasts.

Table 12: Final Scores

	Pharmaceuticals		Financials		Telecom	Total
U.S.	Average score = -1		-2		6	3
	Merck: 1 - 1 = 0	Pfizer: -1 - 1 = -2				
Germany	0		Average score = 0		-3	-3
			Deutsche: 0 + 0 = 0	Dresdner: 0 + 0 = 0		
U.K.	4		-1		-3	0
Total	3		-3		0	

The scores in Table 12 reflect all four analyst forecasts: The U.S. has a higher combined score than Germany; global pharmaceuticals has a higher combined score than global financials; U.S. pharmaceuticals score below German financial companies; and Merck has the same score as Deutsche Bank.

To recap, we start by identifying what type of information we are trying to incorporate and categorizing it appropriately. We use a matrix representation where each cell in the matrix represents a unique country-industry combination. We then combine the country and global forecasts since these are independent signals and overlay the local industry forecast. Within each final modified country-industry cell, we incorporate our stock-specific forecasts. Even more importantly, in the process of reconciling the forecasts, we have uncovered previously overlooked information relating to the performance of other sectors and individual companies.

Lastly, the manager's confidence in the information sources and/or his risk aversion can be used to weight the information layers. For instance, the optimal weights can be determined by the desirable risk allocation, which in turn reflects the combination of each layer's information ratio and risk aversion. Assuming a quadratic utility function,  $U = (IR - \lambda\omega)\omega$ , the optimal level of active risk is given by:

$$\omega^* = \frac{IR}{2\lambda} \tag{1.1}$$

Here,  $IR$  is the information ratio,  $\lambda$  is a risk aversion, and  $\omega$  is active risk. If the three layers of investment decision making are independent, Equation (1.1) gives an optimal risk allocation to each layer. The Barra Integrated Model can be used to forecast risk of each layer's allocation in an effort to keep it at the level suggested by the Equation (1.1).

## Conclusions

Keeping track of the sources of information is an important and essential task for any portfolio manager. Managers are better off if they can identify independent investment decisions, and at the same time, use all the available information at their disposal. The complexity of today's information environment calls for more structured information processing methods allowing managers to process an abundance of data with varying degrees of granularity. Here, a framework is presented based on three layers - global-relative, local-relative, and asset-relative information. From here, more layers may be added as needed, such as a regional equity layer, or expanded to accommodate other asset classes.

Using this approach as an organizational principle helps reconcile varying bits of knowledge and may uncover previously overlooked views required to make the information self-consistent. By enforcing a system of checks and balances, this structured approach may help with information validation. Another advantage is its modularity, allowing for easy addition of new information or discarding of old (or compromised) forecasts. Finally, this approach may also be useful in dealing with information of different timescales or horizons.

## References

- [1] Baca, Sean, Brian Garbe, and Richard Weiss. 2000. "The Rise of Sector Effect in Major Equity Markets", *Financial Analyst Journal*, vol. 56, no. 5 (September/October):34-40
- [2] Brooks, Robin, and Marco Del Negro. 2002. "The Rise in Comovement across National Stock Markets: Market Integration or IT Bubble", Federal Reserve Bank of Atlanta, Working Paper 2002-17a.
- [3] Cavaglia, Stefano, Christopher Brightman, and Michael Aked. 2000. "The Increasing Importance of Industry Factors", *Financial Analyst Journal*, vol. 56 (September/October):41-54
- [4] Cavaglia, Stefano, and Vadim Moroz. 2002. "Cross-Industry, Cross-Country Allocation". *Financial Analyst Journal*, (November/December).
- [5] Griffin, J.M. and G.A. Karolyi. 1998. "Another Look at the Role of the Industrial Structure of Markets for International Diversification Strategies", *Journal of Financial Economics*, vol. 50.
- [6] Grinold, Richard C., Andrew Rudd, and Dan Stefek. 1989. "Global factors: Fact or fiction", *The Journal of Portfolio Management* (Fall).
- [7] Hamelink, Foort, Hélène Harasty, and Pierre Hillion. 2001. "Country, Sector or Style: what matters most when considering Global Equity Portfolios", Lombard Odier.
- [8] L'Her, Jean-François, Oumar Sy, and Mohamed Yassine Tnani. 2002. "Country, Industry, and Risk Factor Loading in Portfolio Management", *The Journal of Portfolio Management*.
- [9] Heston, Steven L. and K. Geert Rouwenhorst. 1994. "Does Industrial Structure Explain the Benefits of International Diversification", *Journal of Financial Economics*, vol. 36.
- [10] Heston, Steven L. and K. Geert Rouwenhorst. 1995. "Industry and Country Effects in International Stock Returns", *Journal of Portfolio Management* (Spring).
- [11] Kritzman, Mark, and Sébastien Page. 2003. "The Hierarchy of Investment Choice: A Normative Interpretation", *The Journal of Portfolio Management* (Summer).
- [12] Puchkov, Anton V., and Frank Nielsen. 2005. "In Search of Global Diversification: Developed and Emerging Markets", MSCI Barra Research Insight.
- [13] Puchkov, Anton V., Dan Stefek, and Mark Davis. 2005. "Sources of Return in Global Investment", *The Journal of Portfolio Management*.
- [14] Rouwenhorst, K.Geert. 1999. "European Equity Markets and the EMU", *Financial Analyst Journal*, vol. 55.
- [15] Scowcroft, Alan, and James Sefton, "Understanding Risk: A New Global Country-Sector Model." UBS Warburg, 2002.
- [16] Stefek, D., F. Hemmati, A. Hsieh, A. Puchkov. 2005. "The Barra Integrated Model: Version 204", Barra White Paper.

## Appendix A

This section describes the main conceptual underpinnings of the Barra Integrated Model. For a detailed description of the model, please refer to Stefek et al. (2005).

As discussed in the paper, traditional global factor models are not designed to capture the increased granularity of local markets. However, simply increasing the number of factors in a traditional global model does not solve the problem. The factors are not independent and the relationships between them have to be estimated. Because the number of relationships grows as a square of the number of factors, increasing the number of factors quickly makes the task of reliably estimating them directly mathematically impossible.

One approach is to abandon the long-standing practice of mapping assets onto a single set of factors and instead map assets onto several factor sets, or layers. An example of this new breed of layered factor models is the Barra Integrated Model (BIM). The model has three layers, each providing an increasing degree of granularity and precision. First, securities are modeled locally by attributing asset returns to industry and style influences in each individual market. These influences are termed *local factors*. For example, the co-movement of U.S. banks is captured by a U.S. banking factor, while that of Japanese banks is embodied in a Japanese banking factor.

However, the local factors themselves are shaped, in part, by the influences of countries, global industries and global styles. For example, the U.S. banking industry is influenced by the performance of the U.S. market and of the global banking industry. Since these factors operate across markets, we designate them *inter-market factors*. These factors form the first, global, layer of our model.

Inter-market factors explain only a portion of local industry and style returns. The part of each local factor return that cannot be explained by inter-market factors is called *purely local*. For example, the purely local U.S. banking factor captures the part of the U.S. banking industry that does not move in lockstep with the U.S. market and global financial sector. The impact of governmental regulation, the state of domestic economies and interest rates, and local investor behavior can all contribute to shaping purely local returns. The purely local factors form the second layer of our factor model.

Finally, asset-specific returns form the third layer of the model. This is the part of a stock return that is idiosyncratic and does not co-move with other assets.

The final asset return decomposition can be presented mathematically as:

$$r = X_g g + X_\phi \phi + u \tag{1.2}$$

Here,  $r$  is a vector of asset excess returns,  $g$  is a vector of inter-market factor returns and  $X_g$  is a matrix of corresponding asset exposures to these factors. Similarly,  $\phi$  and  $X_\phi$  are corresponding matrices for the purely local factors. Finally,  $u$  is the vector of asset-specific returns.

**Appendix B**

This appendix illustrates how multiple quadruples can be layered in the local-industry overlay matrix to create a consistent set of scores.

We consider a similar case to the example we used in the body of the paper; only here, we modify the U.S. and Pharmaceuticals scores slightly.

**Table A1: Scores for Countries and Global Industries (Global-Relative Layer)**

<b>Layer 1: Global Relative</b>	
<b>Analyst Forecast 1 (Country)</b>	
U.S.	+1
Germany	-1
U.K.	0
<b>Analyst Forecast 2 (Global Industry)</b>	
Pharmaceuticals	+1
Financials	-1
Telecom	0

Local industry scores remain the same:

**Table A2: Local Industry Scores (Local-Relative Layer)**

<b>Layer 2: Local Relative</b>	
<b>Analyst Forecast 3 (Local Industry)</b>	
U.S. Pharmaceuticals	-1
German Financials	0

As before, we start by linearly combining country and industry scores into a global-relative allocation matrix.

Table A3: Global-Relative Allocation Matrix

		Pharmaceuticals	Financials	Telecom
	Rank	+1	-1	0
U.S.	+1	2	0	+1
Germany	-1	0	-2	-1
U.K.	0	+1	-1	0

How do we address the fact that the scores above conflict with Analyst Forecast 3 which predicts that U.S. pharmaceuticals will likely under-perform German financials?

We consider the following quadruple for our overlay matrix:

Table A4: Local Relative Allocation Matrix

	Pharmaceuticals	Financials	Telecom
U.S.	-3	0	+3
Germany	0	0	0
U.K.	+3	0	-3

Combining Tables A3 and A4, we get:

Table A5: Combined Global-Relative and Local-Relative Allocation Matrix

		Pharmaceuticals	Financials	Telecom	Country Totals
	Rank	+1	-1	0	
U.S.	+1	$2 - 3 = -1$	$0 + 0 = 0$	$+1 + 3 = 4$	+3
Germany	-1	$0 + 0 = 0$	$-2 + 0 = -2$	$-1 + 0 = -1$	-3
U.K.	0	$+1 + 3 = 4$	$-1 + 0 = -1$	$0 - 3 = -3$	0
Industry Totals		+3	-3	0	

However, this result conflicts with Analyst Forecast 3 which predicts that U.S. pharmaceuticals will likely under-perform German financials. How do we incorporate Analyst Forecast 3?

Let's add another "quadruple" to Table A4:

Table A6: Revised Local Relative Allocation Matrix

Quadruple 1

	Pharmaceuticals	Financials	Telecom
U.S.	-3	0	+3
Germany	0	0	0
U.K.	+3	0	-3

+ Quadruple 2

	Pharmaceuticals	Financials	Telecom
U.S.	0	-2	+2
Germany	0	+2	-2
U.K.	0	0	0

= Local Relative Allocation Matrix

	Pharmaceuticals	Financials	Telecom	Total
U.S.	$-3 + 0 = -3$	$0 - 2 = -2$	$+3 + 2 = 5$	0
Germany	$0 + 0 = 0$	$0 + 2 = 2$	$0 - 2 = -2$	0
U.K.	$+3 + 0 = 3$	$0 + 0 = 0$	$-3 + 0 = -3$	0
Total	0	0	0	

Now if we overlay this table on our original one in Table A3 the result we obtain below satisfies all forecasts:

Table A7: Revised Combined Global-Relative and Local-Relative Allocation Matrix

		Pharmaceuticals	Financials	Telecom	Country Totals
	Rank	+1	-1	0	
U.S.	+1	$2 - 3 + 0 = -1$	$0 + 0 - 2 = -2$	$+1 + 3 + 2 = 6$	+3
Germany	-1	$0 + 0 + 0 = 0$	$-2 + 0 + 2 = 0$	$-1 + 0 - 2 = -3$	-3
U.K.	0	$+1 + 3 + 0 = 4$	$-1 + 0 + 0 = -1$	$0 - 3 + 0 = -3$	0
Industry Totals		+3	-3	0	

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