CONSULTATION REPORT OF THE GLOBAL HEALTH FORECASTING WORKING GROUP

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LIST OF ACRONYMS

ACT	Artemisinin combination therapy (for malaria)
API	Active pharmaceutical ingredient
ARV	Antiretroviral therapy (for HIV/AIDS)
CGD	Center for Global Development
CHAI	Clinton Foundation HIV/AIDS Initiative
GAVI	Global Alliance for Vaccines & Immunization
GFATM	Global Fund to Fight AIDS, Tuberculosis & Malaria
IFFIm	International Finance Facility for Immunization
MMV	Medicines for Malaria Venture
NHS	UK National Health Service
OECD	Organization for Economic Cooperation and Development
PDP	Public-private product development partnership
PPP	Public-private partnership
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PMI	U.S. President's Malaria Initiative
RBM	Roll Back Malaria
TB	Tuberculosis
UNICEF	United Nations Children's Fund
UNITAID	International Drug Purchase Facility
WHO	World Health Organization

PREFACE

Whether global health programs achieve their objectives depends, in large measure, on whether products appropriate to the health problems in low- and middle-income countries are developed, manufactured and then made available when and where they are needed. Part of the solution lies in mobilizing public and charitable money for more and better products to diagnose, prevent and treat HIV/AIDS, TB, malaria, reproductive health problems and childhood killers. But more money is only one part of the story. Weak links in the global health value chain – from R&D through service delivery – are constraining on-the-ground access to essential products to prevent and treat many diseases. The consequences of those weak links are many: supply shortages, inefficient use of scarce funding, reluctance to invest in R&D for developing country needs, and, most importantly, the loss of life and health among those who need essential products.

One of the weakest links, and one of the most vital for achieving both short- and long-term gains in global health, is the forecasting of demand for critical medical technologies, including vaccines, medicines and diagnostic products. Demand forecasting, which may seem at first glance to be a small piece of the very large puzzle of access to medical products, is of central importance. Many of the shortcomings in funding and functioning of health systems impede accurate forecasting of demand, and without the ability to forecast demand with a reasonable degree of certainty, manufacturers cannot scale production capacity, make commitments to suppliers of raw materials, or see a business case for investing in costly clinical trials and other activities to develop future products. National governments and international funders rely on demand forecasts for budgeting purposes, while health programs and implementing agencies depend on forecasts to plan their supply chain logistics. Thus, in the high-level policy debates about the volume, duration and use of donor monies to support R&D and purchase of essential health products, one key fact has often been overlooked: if actions by the international community do not contribute to a greater ability to generate credible forecasts of demand – if, in fact, those actions contribute to a situation of greater uncertainty, with higher stakes – efforts to achieve the goal of greater access to life-saving and life-extending medicines will be undermined.

The challenge is an urgent one. The past several years have seen an influx of new monies, new products, new suppliers and many new organizations providing technical services in global health, making the flow of funds and information far more complex than it was in the past. In the foreseeable future, we will see more financial resources being devoted to product procurement for AIDS, TB, malaria, vaccine-preventable diseases and other conditions, and we will see a significant number of new products move to licensure and become available in the market. While this rapid evolution represents a tremendous achievement, the ability of all the new funding, products and technical resources to achieve their full potential depends on far more serious and successful efforts to provide credible and accurate forecasts of demand to key players as a way to reduce risk and increase efficiencies. Moreover, it requires efforts to share the remaining risk in a way that encourages all parties – on both supply and demand sides – to work together toward broad and equitable access to essential medical technologies.

Recognizing the importance of demand forecasting, and believing that improvements are possible through "win-win" solutions in this key area, the Center for Global Development convened the Global Health Forecasting Working Group in early 2006, after a six-month period of consultation with knowledgeable individuals to define the nature of the problem and sketch out potential

solutions. The Working Group, consisting of 27 individuals with a range of expertise from industry, public-private partnerships, funding agencies, and other backgrounds (see Appendix A for list of members) found that forecasting challenges can be understood only by looking at the nature and distribution of underlying risks faced by the pharmaceutical industry, regulatory and purchasing intermediaries and funders, particularly in light of the new global health environment of more money, new products and a more complex international market. They recognized early on that the solutions – not only to the issue of better forecasting, but to the larger concerns about reliable and expanded access to essential products – lie in strategies that reduce and share risk.

Together, the group examined the ways in which better forecasting could contribute to improved short- and long-term access; developed an understanding of market-related risks for global health products that combines a conceptualization of risk from economics with a focus on steps in the value chain; identified the ways in which the asymmetrical burden of risk across funders, regulatory and purchasing intermediaries and suppliers results in misaligned incentives with respect to producing optimal demand forecasts and broad access; and advanced a set of specific recommendations for actions by donors and technical agencies that would help to reduce overall risk and correct those misalignments. The group developed recommendations for "here and now" actions, framed within a longer-term agenda of work on health systems, regulatory regimes, technology development and predictable international financing for health.

Throughout, the group concentrated on problems associated with "new products/new markets" – that is, those products that are newly licensed and/or are new entrants into use in developing countries. This scope was adopted because the challenges of demand forecasting – and the consequences of demand uncertainty – are most pronounced for these products. Such products tend to be produced or made available in countries by a limited number of quality manufacturers; manufacturing processes and regulatory factors may be less predictable than for products that have a long track record; newer products are generally high-value, and donor dollars (rather than national resources) are used to purchased them for use in low-income countries; and, importantly, future usage patterns are difficult to project because of the limitations in historical consumption data. In short, while demand forecasting is challenging for many health products, it is the products that are new to developing country markets for which the hurdles are most acute and for which donor actions can have the greatest impact. This report focuses on the forecasting-related issues and opportunities that are shared by many products entering use in developing countries, but recognizes that each product type faces a unique manifestation of a core set of risks, depending on the characteristics and dynamics of the market including level of competition, opportunities for price reduction, and other factors. The Working Group, which was comprised of individuals with expertise in many different product categories, consistently reflected on the varied market situation in the conduct of its deliberations, while at the same time looking for solutions that spanned products.

This draft report is based on analyses, discussions and other inputs from the Global Health Forecasting Working Group, which was convened by the Global Health Policy Research Network, a program of the Center for Global Development. (See Appendix A for a list of Working Group members.)

While the current draft position paper represents the views of the authors (Sekhri, Levine and Pickett) and not necessarily the views of any of the individuals who participated in the Working Group, we have attempted to accurately represent the areas of agreement among Working Group members. With the distribution of this draft position paper, we are soliciting comment and critique from a broad set of interested parties from February 20 through March 23, 2007, and will use those views to finalize the work of the group by April 2007. Please address comments to the authors, Neelam Sekhri (nsekhri@hcredesign.com), Ruth Levine (rlevine@cgdev.org), and Jessica Pickett (jpickett@cgdev.org).

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I. THE CASE FOR BETTER DEMAND FORECASTS

Lack of accurate and credible information about effective demand for critical medical technologies costs lives. Crucial decisions about which vaccines, medicines and diagnostics to produce and what to buy hinge on projections of the future market – not only what ideally would be required to meet the potential need – so gaps and weaknesses in demand forecasting result in a mismatch between supply and demand. If forecasts are off, so are the outcomes: limited funds to purchase products do not stretch as far, and the chance of shortages are higher than would otherwise be the case. The most important consequences are to health: Children fail to get malaria medicines and vaccines that will save their lives, pregnant mothers and their babies go unprotected from exposure to malaria and the transmission of HIV, and AIDS patients miss their medicine cycles, jeopardizing their lives and adding to the threat of drug resistance within their community. The negative economic effects are profound, as well. Uncertainties about demand significantly weaken the business case for involvement in developing countries by both branded and generic manufacturers, and have immediate and long-term impacts on access to life-saving products.

Demand forecasting is defined as the ongoing process of projecting which products will be purchased, where, when, and in what quantities (given assumptions about price and other determinants of demand). The type of information required for demand forecasting includes projections of the incidence and prevalence of health conditions, health system coverage, economic and finance variables, and data on consumer behavior.

Demand forecasting is not a new challenge. But the imperative to do better forecasting has become acute in the context of the current efforts to increase access to essential medical technologies. Without the ability to forecast effective demand – as distinct from aspirational targets – with a reasonable degree of certainty, manufacturers cannot scale production capacity, make commitments to suppliers of raw materials, or see a business case for investment in costly clinical trials and other activities to develop future products. Similarly, national governments and international funders rely on demand forecasts for budgeting purposes, while health programs and implementing agencies depend on forecasts to plan their supply chain logistics.

Traditionally, demand forecasting for health products in developing country markets was seen as a relatively low-level function, to be left to firms with particular business interests, with some basic information about health conditions and health system coverage being provided by technical agencies. More recently, with increased attention on getting new products into broad use to address highly visible public health priorities like HIV/AIDS, creating good demand forecasts that can be agreed to by multiple stakeholders has taken on new importance. In an incremental fashion, product-by-product, the global health community has responded; for example, WHO has taken the responsibility for developing forecasts for some products, and for others impressive efforts have been made by a set of public-private partnerships. However, relatively little has been done across products to address weaknesses in data, methods and institutional incentives that would engender credible forecasts for the best possible decisionmaking.

The need to take demand forecasting seriously and to improve forecasts is urgent; the stakes are far higher than they have ever been. The stakes are higher because, more than in the past, shortages or interruptions of the supply of drugs harm individuals' health and damage community well-being through the spread of infection and the emergence of drug resistance; vastly more money is being

spent overall, and more money is being spent on each product unit; and firms that develop and supply essential products in developing world markets will continue to do so only if the international public health community and funders provide credible, realistic estimates of market potential.

Recognizing the importance of demand forecasting, and believing that improvements are possible through "win-win" solutions, the Center for Global Development convened the Global Health Forecasting Working Group in early 2006, after a six-month period of consultation with knowledgeable individuals to define the nature of the problem and sketch out potential solutions.[1] The Working Group, consisting of 27 individuals with a range of expertise from industry, public-private partnerships, funding agencies, and other backgrounds (see Appendix A for list of members) found that demand forecasting can and must be improved so that current global health investments realize their potential. The group concluded that forecasting challenges can be understood only by looking at the nature and distribution of underlying risks faced by the pharmaceutical industry, regulatory and purchasing intermediaries, and funders, particularly in light of the new global health environment of more money, new products and a more complex international market. Those risks, which are asymmetrically distributed, imply distinct and misaligned incentives across important players in the global health market; under current arrangements, those misaligned incentives conspire to impair demand forecasting and, more importantly, hamper broader access to critical medical technologies.

The group recognized that the near-term solutions – not only to the narrow technical issue of better forecasting, but to the big-picture concerns about reliable and increasing access to essential products – lie in mutually reinforcing strategies designed to break the cycle of bad information, inaccurate forecasts and lack of incentives to do better. These strategies include: taking forecasting seriously and adopting principles of good forecasting; reducing risk through better mobilization, sharing and generation of information; and aligning incentives by sharing risk. These solutions fit within a broader and longer-term policy agenda of strengthened health system capacity; improved regulatory and post-regulatory processes at global and national levels; more market-oriented product development; and increased predictability of international finance for health.

Focus of the Working Group

Throughout its work, which is summarized in this report, the Working Group concentrated on aggregate demand forecasts at the global level (rather than country-specific) for "new products/new markets" – that is, those products that are newly licensed and/or are new entrants into use in developing countries, as opposed to currently available and widely distributed therapies. This scope was adopted because the challenges of demand forecasting and the consequences of demand uncertainty are most pronounced for these products. Such products tend to be produced or made available in countries by only a limited number of quality manufacturers, and manufacturing processes and regulatory factors may be less predictable than for products that have a long track record. Newer products generally are offered at higher unit prices relative to off-patent products, and consequently donor dollars are used to purchased them for use in low-income countries; this introduces additional risks and forecasting challenges not necessarily faced when national governments are payers. And, importantly, future usage patterns are difficult to project in this situation because of limited historical consumption data. In short, while demand forecasting is challenging for many medical products, it is the "new products/new markets" for which the hurdles are most acute and for which donor actions can have the greatest impact.

This report focuses on similarities across products and product categories but recognizes that each type of new product faces a unique manifestation of a core set of risks, depending on the characteristics and dynamics of the market including level of competition, affordability, and other factors. For example, antiretrovirals were originally developed in response to needs and demand in developed countries, and the lion's share of the R&D investments were recouped through those markets; although they are still considered new products as their use is scaled-up in countries with a heavy AIDS burden, several first-line therapies are being produced by generic manufacturers and, both because of this supply situation and because of impressive negotiations at the international level, are offered at a far lower price than was the case only a few years ago. At the same time, second-line ARVs are provided by a small number of multinational suppliers, and are offered at relatively high (albeit concessional) prices. In constrast, malaria drugs have little or no developed-world market. The market in endemic countries is divided between high quality modern ACT combination therapies, which are produced by a small number of suppliers and are subject to price and procurement scrutiny. In parallel, another market exists of low efficacy products, based on older drug classes and often produced in endemic countries. Suppliers in the malaria field require clarity on both these markets to improve supply of effective anti-malarial medicines. Most vaccines, beyond the traditional products that are now largely off-patent, are produced by a small number of multinational manufacturers, are offered at prices substantially higher than the "commodity-type" products, and have both developed and developing country markets. The Working Group, which was comprised of individuals with expertise in many different product categories, consistently reflected on the varied market situation in the conduct of the deliberations, while at the same time looking for solutions that spanned products.

The rest of this chapter provides an overview of the new context, with a focus on how recent changes have dramatically increased the challenge as well as the importance of good demand forecasting; the chapter also highlights the role of demand forecasting within the value chain for medical products. Chapter II focuses on the **underlying risks and misaligned incentives** that contribute to the challenges of demand forecasting; without addressing these any solutions are likely to be superficial and of limited success. Chapter III presents the first recommendation of the Working Group – to **take demand forecasting seriously** – spelling out the core principles of good demand forecasting that are accepted across a range of sectors, and discussing the implications of adopting those principles in global health. Chapter IV focuses on the second recommendation of the Working Group, describing how strategic investments could be used to **create a global health infomediary**, which would address – in a coordinated way – the gaps in the information base required to generate credible forecasts that are as accurate as possible. Chapter V focuses on the third recommendation, providing a menu of possible new ways to **use risk-sharing contracts to align incentives** across suppliers, funders and those actors throughout the supply chain that are affected by funders' policies and practices. Finally, Chapter VI places these near-term actions within the longer-term policy agenda, lending the Working Group's voice to calls for important progress on health systems strengthening, regulation, development and financing of critical medical technologies.

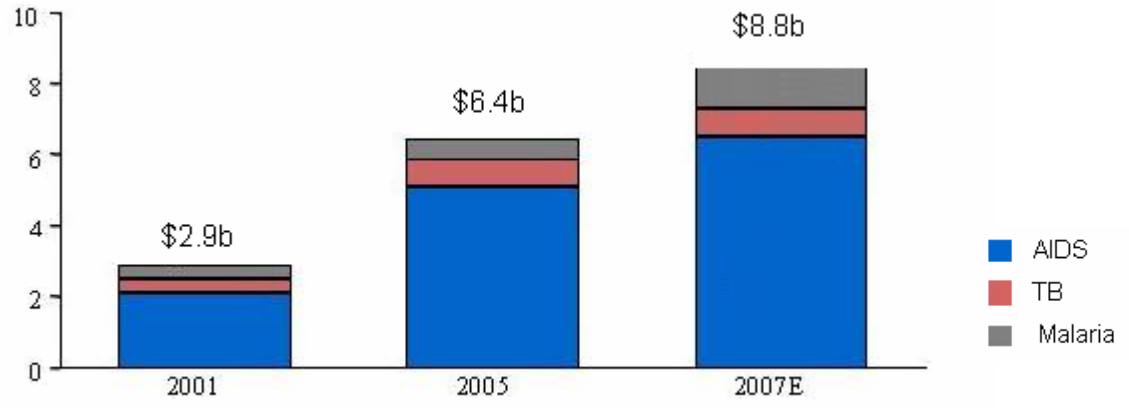
The New World of Global Health

Understanding why demand forecasting is key to future progress in global health requires a look at five recent changes: new amounts and sources of money; new and future products; new buyers; new suppliers and business models; and new intermediaries.

***New amounts and sources of money*:** In the developing world, the three main sources of finance for health products are private, out-of-pocket spending; national or sub-national public sector payers, typically channeled through the Ministry of Health; and international public and private donors. Although expenditures by all three sources have been gradually increasing in most countries, it is the expansion in international public sector donor monies that is creating a discontinuity in the resources available, particularly in the lowest income countries. As this has happened, the policies and practices of both traditional and new donor agencies have become a driving force in the market.

Donor funding for global health has increased substantially in the past five years, particularly for HIV/AIDS, tuberculosis, malaria, and vaccines. The U.S. alone authorized up to $15 billion for HIV/AIDS through the President's Emergency Plan for AIDS Relief (PEPFAR) from 2003 to 2008 and $1.2 billion for malaria from 2005-2010 through the President's Malaria Initiative.[2, 3] The Global Fund has almost $10 billion dollars in assets today and has already committed $6.6 billion to programs. Globally, annual funding for AIDS, TB and malaria has more than doubled from 2001 to 2005; by 2007 the funding target is $15 billion for the three diseases, with $8.8 billion already committed by major donors.

Figure 1.1 Funding for AIDS, TB and Malaria, 2001-2007 estimates (Sources: PEPFAR, Global Fund & World Bank)



Note: Funding estimates are for all activities, not just procurement of products; however, at least half of spending is likely to be devoted to critical medical technologies (drugs, diagnostics, bednets).

For vaccines the situation is similar. In 2004, UNICEF alone purchased 2.8 billion doses of vaccines worth a total of $374 million, compared to only 969 million doses worth $55 million in 1990 – an almost 600% increase in spending.[4] Most of this new money has come through the GAVI Fund, which has raised $1.3 billion already and has pledges for an additional $1.32 billion. In 2006, the International Finance Facility for Immunization (IFFIm) was launched with the expectation of generating an additional $4 billion over the next 10 years for the purchase of vaccines through GAVI.[5]

These new monies are being channeled through newly created mechanisms. Beyond the Global Fund and GAVI, which are now reasonably well established players in global health funding, even

newer approaches are being launched. In 2006, the International Drug Purchase Facility/UNITAID was created to channel new monies from the French airline levy and other donors. It is expected that UNITAID will mobilize at least $300 million annually, dedicated specifically to health products. Several donors, including Italy, the UK and Canada, have joined forces to fund a pilot Advance Market Commitment, which would mobilize approximately $1.5 billion for the procurement of pneumococcal conjugate vaccine for low-income countries if and when an appropriate product is developed.[6] A subsidy program for artemisinin combination therapy for malaria is under development by the World Bank, which would come with its own funding streams.

The increase in funds and funders has had significant impacts on the overall supply chain that affect demand forecasting. First, donor funding is notoriously unpredictable, and tends to be more subject to rapid fluctuations than the national public finance in developing countries. Commitments are not always reflected in disbursements, and funding can be cut off instantly if and when there are allegations of corrupt practices or other major governance concerns. While several of the new funding instruments are designed to create a more predictable flow of funding, the risks associated with reliance on donor funding imply a major challenge for forecasting demand.

Second, the increase in demand for products is a major step change for global capacity, not an incremental one. Between 2002- 2005, the Global Fund disbursed $1.6 billion, but in 2006 alone it will disburse an additional $1.2 billion.[7] About half of these monies are committed for the purchase of drugs and supplies.[8] The majority of UNITAID's annual funding will also be committed to buying drugs and commodities for AIDS, TB and Malaria.[9]

If the money is there, will the products be, too? The major increase in funding and subsequently in demand for products requires large investments by manufacturers to scale up production capacity. Within countries, it implies the need for greatly expanded procurement, warehousing, storage, and logistics capabilities. Both require accurate forecasts to plan for and justify investments.

The impact of new aid instruments, through which much of the new funding is being channeled, rely heavily on the assumption that developing country supply chains can deliver products quickly, efficiently, and at a large scale. These new funding instruments, all of which cite performance as a criterion for continued funding, expect countries to show measurable results in a short period of time to justify continued disbursements. For example, Global Fund grants are initially approved for five years, but after the first two years of the grant cycle recipients must demonstrate good performance against targets to continue to receive funds. According to the Global Fund's estimates, the procurement process alone for medicines and supplies could take up to 18 months during its first round,[10] a figure consistent with experience from the World Bank.[11] To meet the requirements of these new aid instruments, procurement mechanisms and supply chain processes must be greatly streamlined and strengthened, requiring investment in skilled staff and infrastructure.

***New and future products*:** As a beneficial result of recent investments in global health, many new products for developing country markets are available or in development. The array of new products has many payoffs for health – for example, newer products that contain artemisinin are effective against malaria that is now resistant to the traditional chloroquine products – but their emergence creates challenges for funders, intermediaries and consumers who are accustomed to having available a relatively small number of commodity-type products with quite well established supply

and procurement relationships. Those challenges will be exacerbated as the late-stage products (new vaccines, anti-malarials and TB drugs, in particular) are licensed and brought to market.

The products now newly available have some characteristics that distinguish them from their older generation therapies; these characteristics highlight why the stakes for good demand forecasting are high, and particularly why manufacturers who are engaging in the global health market are keen to see major progress in forecasting accuracy.

First, many of them are still on patent. As a result, their prices reflect manufacturers' desire to recoup R&D investments, and little competition. The unit prices are relatively high, compared to products from earlier generations that are now off-patent.

Second, some products, such as ACTs, have short shelf-lives and long production cycles with active ingredients dependent on unreliable agricultural processes. Manufacturing for these products is characterized by long lead times that often depend on a limited number of global suppliers and are subject to economic and political disruptions. For ACTs, on average, the process of production from raw materials to finished product takes almost 18 months, and building and accrediting manufacturing facilities takes at least three years.

Third, for some key products, supply shortages or stock-outs at any point in the distribution chain imply major negative public health consequences. For ARVs, for example, an interruption in a patient's treatment can quickly lead to death for them, and/or the potential of viral drug resistance in the community. For TB drugs, stock-outs bring with them the possibility of developing multi-drug resistance. Some 420,000 new cases of multi-drug resistant TB (MDR-TB) are diagnosed around the world each year and 7% of the MDR-TB cases now show resistance to three or more drugs. [12,13]

Fourth, many of these products represent a high level of technological complexity, which makes the possibility of low-cost generics less likely in the short-term. In vaccines, for example, conjugate vaccines require advanced technology and production know-how that are still out of the reach of most generic manufacturers.

Finally, some of these products are provided by a limited number of quality suppliers or produced only by generic manufacturers based in emerging countries. These suppliers may find it prohibitive or impossible (for example, if the drug is still under patent) to apply for approval through a stringent regulatory authority. To respond to these issues, WHO has set up a new prequalification system for the approval of drugs for the developing world. However, the approval process has averaged two years, which has further limited the number of qualified suppliers on the market for a variety of products.[14]

New buyers: With the new monies have come new buyers, some with limited experience in international pharmaceutical procurement. This has consequences for the ability to forecast the volume and timing of purchases. The most prominent example is in the grants provided by the Global Fund, which has decentralized purchasing power to more than 400 buyers in 132 countries, including public entities, NGOs, and faith-based organizations.[15] The original intent of the Global Fund's procurement design was to promote country ownership and improve local capacity in purchasing and supply chain management. In practice, however, this approach has significantly

burdened in-country supply chains, and has created a market characterized by small, disaggregated buyers with limited ability and experience to influence quality, price, packaging, shelf life, availability or delivery times of products. For example, the Global Fund's price reporting mechanism shows that in 2006, there was an almost eight-fold difference in the price for Nevirapine, a common first-line ARV; purchase prices in low-income countries in Africa ranged from $58 per patient/year to $438 per patient/year.[16]

Many of these smaller new buyers have little capacity and experience in demand forecasting, negotiation, procurement and contract management. Their decision processes, price sensitivities, competing priorities and political realities are poorly understood by suppliers and others in the market. This makes it both difficult to accurately predict their demand and costly to forge the partnerships required to generate trust among participants in the market, on both supply and demand sides.

Box 1.1 GAVI and the Global Fund: Different Approaches the Market

We found that most of the problems in achieving our Global Fund performance targets were directly caused by difficulties with procurement. – Dr. Simon Mphuka, Churches Health Association of Zambia

GAVI and the Global Fund, the two large new funding mechanisms have chosen to approach their intervention in the supply chain and in product procurement in very different ways. GAVI chose to centralize procurement of vaccines through a single procurement agent, UNICEF which negotiated framework contracts with suppliers for the entire market of grantees. Grantees were given the option of either buying through UNICEF or procuring products independently. However, GAVI would only reimburse them up to the amount that they would have paid through UNICEF. As a result, all countries chose to procure through the centralized UNICEF contracts. In essence this meant that GAVI delivered products directly to countries rather than giving them money to buy products.

The Global Fund, in keeping with its principle of country ownership, chose to provide money to grantees rather than products, and have recipients procure products individually using their own processes. While this arrangement provides maximum flexibility for recipients, it has also been found to increase price and currency risks, does not leverage the Global Fund's huge purchasing power, and contributes to long delays in procurement of essential products.

The Global Fund recently commissioned a study evaluating this design, which found that recipients would welcome a more managed approach to procurement and recommends that the Global Fund pursue a voluntary pooled procurement mechanism where recipients could ask the Global Fund to establish framework contracts on their behalf and pool procurement activities.[17] The Global Fund Board endorsed these recommendations in November 2006.

In contrast to the Global Fund's approach, the GAVI Fund, which provides grants to countries for vaccines, injection supplies and strengthening of immunization programs, has primarily used traditional UNICEF procurement arrangements (see Box 1.1 for more details). Also, because the GAVI Fund has a longer funding horizon than the bilateral donors that have traditionally financed UNICEF vaccine purchases, it has been possible to engage in longer-term procurement arrangements. This has clear benefits but makes it essential to obtain good mid- and long-term forecasts of demand.

New suppliers and business models: The number of suppliers continues to grow, in part because multinational companies are showing a willingness to license production in developing countries to

respond to urgent public health needs. However, this does not necessarily guarantee greater access to quality products because of bottlenecks in the regulatory and post-regulatory steps. For example, Cosmos, a producer in Kenya has received voluntary licenses from Roche and Boehringer Engeilheim to produce two AIDS drugs. Because it has not completed the WHO pre-qualification process, however, Cosmos is unable to bid for government tenders to provide ARVs through donor-funded programs.[18] Because of issues with pre-qualification and cumbersome national registration processes, although there are over four qualified ARV suppliers for the common first-line ARVs, only one or a maximum of two suppliers typically are registered in any given country.[19] This makes countries vulnerable to suppliers' production or delivery problems.

Even as the number of developing country suppliers is expanding, recent changes in rich country markets may actually decrease the security of supplies to the developing world. Several Organization for Economic Cooperation and Development (OECD) countries have introduced initiatives to reduce the rate of increase in drug costs and expand markets for generics; these actions increase the attractiveness of these markets for developing country generic companies. For example, over the next five years, patents for several of the most common ARVs are due to expire. Even today, HIV/AIDS drugs are estimated to contribute only 10-15% of the profit margin of the two largest Indian generic manufacturers, Cipla and Ranbaxy, both of which already sell a wide range of generics to OECD countries.

As with new buyers, new developing country suppliers often lack expertise in forecasting demand, negotiation and procurement. Their motivations, decision processes, and internal realities are not well understood by buyers or international agencies, and partnerships with these new suppliers based on trust are still being formed.

For traditional manufacturers, the situation is complicated by the fact that prices in some of the lower-income countries are set to recover costs, rather than to generate profit. Faced with vast public health needs and the threat of reputational damage, suppliers have shown willingness to accept low or even zero margins, but this greatly impedes their willingness and ability to invest in production capabilities without some assurance of demand. In some cases, given the low returns compared to other markets suppliers' sales objectives are to make the drug available, not necessarily to promote sales. At the same time, the costs of doing business in developing countries tend to be higher than in developed markets because of supply chain complexities, country-specific packaging in multiple languages and other registration requirements, and uncertainty of funding.

Further complicating the picture is the competition in the market between quality pharmaceutical products and counterfeits. As the health care market in developing countries has grown, often without parallel strengthening of the regulatory framework and enforcement, low-quality and counterfeit products have taken a firm foothold in many countries. According to the WHO, about one-quarter of the medicines consumed in developing countries is counterfeit; in some countries, this figure may be close to 50 percent.[20] One study found that up to 40 percent of products that were supposed to contain artusenate anti-malarial in fact contained no active ingredients.[21]

***New intermediaries*:** In addition to the growth in funders, buyers and suppliers, many new intermediary organizations have entered the global health products market, each playing a particular role albeit not always in coordination with other players. Some of these organizations have novel structural arrangements involving relationships between public and private sectors, and these

institutions are characterized by evolving management and governance. For example, several public-private partnerships have been created in the past few years that are designed to encourage the development and/or introduction of specific new products for neglected diseases (most with significant funding from the Bill & Melinda Gates Foundation); these include the Foundation for Innovative Diagnostics, International Partnership for Microbicides, AERAS Vaccine Fund, PneumoADIP, International AIDS Vaccine Initiative, Medicines for Malaria Venture, Institute for OneWorld Health, Rotavirus Vaccine Program, the Global Alliance for TB Drug Development, and others.[22] In addition to managing or facilitating product development, several of these partnerships have taken responsibility for creating demand forecasts through the product development phase and managing the introduction of new products into the market. Recently, the Clinton Foundation's HIV/AIDS Initiative (CHAI) has become a central player in the ARV supply chain by negotiating ARV prices with suppliers and active pharmaceutical ingredient (API) manufacturers, preparing demand forecasts, and advising countries on procurement and supply management. It will soon expand its role to include similar functions for ACTs.

As new entities have sprung up, agencies with longer histories have expanded or deepened their involvement in health product markets and supply chains as well. WHO is involved in prequalification of a wide range of products and procures specific drugs, in addition to its normative role of establishing treatment guidelines and proposing essential drugs lists. Public-private partnerships have been established under the WHO umbrella, such as Roll Back Malaria and the Stop TB Partnership, which are involved in drug policy, forecasting and procurement. UNAIDS also has created an Accelerated Access Initiative with major ARV manufacturers to increase availability of these products. UNICEF has expanded its role as the major procurement program for vaccines to procure ACTs, ARVs and other health products as well.

Box 1.2 Who are the Stakeholders? Examples from the HIV/AIDS Market

The value chain for any global health product involves multiple stakeholders, each with their own role, governance, financial and other incentives, and sets of relationships with other players. To give a sense of the diversity and complexity, key stakeholders in the market for antiretrovirals are listed below:

Supply Side Facilitators play the important role of funding late-stage research, providing information pertaining to long term market potential, funding clinical trials, helping the manufacturers to obtain better rates from Contract Research Organizations (e.g. Quintiles) and facilitating relationship of smaller manufacturers with international regulatory and technical organizations such as the WHO and national health and regulatory authorities. The Clinton Foundation's HIV/AIDS Initiative is one example of a supply side facilitator in the ARV supply chain.

Manufacturers are responsible for the development, production and sale of ARVs to the mass market. Qualified manufacturers, such as Bristol-Myers Squibb, Cipla, and Ranbaxy, have products that are Pharmaceutical Inspection Cooperation Scheme (PIC/S) approved; and non-qualified manufacturers currently do not have PIC/S approval for their products.

Quality Regulators, such as the WHO, FDA, EMEA, and PIC/S, are responsible for ensuring the quality of the drug. Funding agencies also apply internal standards that guide which manufacturer recipient countries can buy from. In addition to being approved by a quality regulator, many buying countries have their own national registration process in which drugs must be registered by a national entity.

Global Technical Agencies, such as the WHO, are responsible for setting treatment norms and guidelines.

Funding Agencies, including the World Bank, the Global Fund, and USAID give grants and loans to HIV/AIDS treatment programs.

Donors are comprised of countries, like the UK Government, and philanthropic foundations, like the Gates Foundation, that give money to funding agencies.

Procurement Agents, such as the Inter-Agency Procurement Services Office (IAPSO), UNICEF, and the WHO assist countries in ordering and purchasing ARVs.

Logistics Providers, such as JSI Deliver, handle shipping and transport of ARVs from the manufacturer to the buying country, and assist in distributing it throughout the buying country.

National Public Buyers, most notably the ministries of health, are the government entities responsible for purchasing ARVs for the public sector.

Aggregate Demand Forecasters, such as the Clinton Foundation and WHO's AIDS Medicines and Diagnostics Service, are responsible for determining the demand forecast for ARVs on a global level.

Demand Forecasting within the Value Chain

The "supply chain" refers to the flow of materials, information, and finances as they move in a process, virtually or physically, from supplier to manufacturer to wholesaler to retailer to consumer. Supply chain activities transform raw materials and components into a finished product, delivered to the end consumer. The "value chain" encompasses the supply chain, but also includes the research and development process.

At virtually each step in the supply chain, and the broader value chain for pharmaceutical products, decision makers depend on information about demand: how many units of a product will be purchased and used in the near, medium and long-term? Failure to provide credible estimates of that demand results in outcomes that are bad for the suppliers and, worse, bad for the people whose lives depend on accurate diagnosis, and access to medicines and vaccines.

Aggregate forecasting estimates the overall size of effective demand in the market, taking into consideration assumptions about price, funding availability, uptake rates and other key factors. Although it is only one step in the long and often complicated value chain, this process represents a key input into decision-making for both buyers and suppliers. For health products, demand forecasting starts when a product is first conceived during the R&D phase and continues throughout the life cycle of that product, and through the value chain (see Box 1.3). If it is not done in a way that optimally uses information and is seen as credible by decisionmakers – particularly in newer markets, given inherent uncertainties – the rest of the value chain cannot be efficiently mobilized to deliver treatment.

Demand forecasting serves five critical functions in the market for global health products and the effective delivery of medicines and supplies, all of which add up to lives saved:

1. **Essential products are available because there is enough supply to meet demand**. Allows manufacturers to plan and invest in manufacturing capacity, ensuring sufficient supply to meet demand and taking advantage of production efficiencies.

2. **New products are developed because there is a realistic picture of future markets.** Provides manufacturers with information about new market potential, permitting them to efficiently allocate resources to develop, produce and commercialize new products that respond to developing country opportunities and accelerating the pace of product availability.
3. **Supply chain capacity is increased so products can get to people who need them**. Enables health systems in developing countries to expand their capacity to deliver products to more patients, matched to the scale and mix of products required.
4. **Funders plan purchases and make the most of the money available.** Allows donors and national governments to efficiently allocate their resources by ensuring appropriate prices and adequate supplies of products.
5. **Public health community sees bottlenecks and opportunities to expand use**. Highlights key demand- and supply-side constraints, and can guide policy and advocacy efforts to reduce those constraints and achieve broader access.

Box 1.3 The Critical and Evolving Role of Demand Forecasting

Demand forecasts are intended to quantify "effective demand" in the market, which means demand for products that is likely to have purchasing power behind it.

A variety of organizations are involved in forecasting needs for specific drugs and products, and in particular countries; some of these are also attempting to forecast effective demand as well. These organizations include, but are not limited to, the WHO, various product development partnerships such as the TB Alliance and the International AIDS Vaccine Initiative, GAVI, the Clinton Foundation (CHAI), the United Nations Population Fund (UNFPA), UNICEF, USAID contractors JSI and Management Sciences for Health (MSH), procurement agents and suppliers. These organizations prepare a range of different types of forecasts ranging from setting targets, mobilizing funding, or engaging in negotiations with particular suppliers.

The demand forecasting process starts early in the product life cycle and forecasts are continually refined as the product gets closer to launch, and then to widespread usage. When a candidate is still in the development pipeline, long-term strategic forecasts are produced, assuming various product specifications. These forecasts, which are based on a set of early assumptions about product characteristics and efficacy, are used to make an R&D investment case for suppliers and/or funders. Before a product is ready to reach the market, or in the case of existing products, when the product is entering new markets, these forecasts are refined to more specifically guide production investment decisions. Once a product has entered the market, demand forecasts, are further refined and detailed to guide short-term production decisions and management of the supply chain.

As Figure 1.2 shows, demand forecasts are essential for every level of the value chain and throughout the product life cycle. They are used by local health facilities, ministries of health, procurement agents, international organizations, and suppliers. The forecasting process and basic principles are the same for all of these forecasts, but their specificity and accuracy changes over time and differs at each level. Forecasts are in continual refinement during the product lifecycle with iterative feedback loops with other areas in the organization and the external environment, reflecting changes as they occur.

This report focuses on aggregate forecasting, which describes forecasts that are combined across regions and countries to produce an overall indication of demand for products in the market. As a product gets closer to launch these forecasts will become more and more reliant on good country level and local forecasting. However, there is a still a need to aggregate these forecasts for suppliers to help them scale up production capacity and smooth out fluctuations in demand between countries and regions.

Figure 1.2 Demand Forecasting Along the Value Chain

	Pre-Product Development	Product Development (Phases I and II)	Large Scale Trials (Phase III)	Product Launch and Post launch (Phase IV)	Product Usage
Supplier	Preliminary forecasts drive R&D investment	Product forecasts drive manufacturing & marketing	Regional/ country forecasts drive sales, manufacturing	Regional/ local forecasts drive sales	Regional/ local forecasts drive sales
PDP	Preliminary forecasts drive suppliers/ funders	Product forecasts drive suppliers/ funders	Regional/ country forecasts drive budgets & funders	Regional/local forecasts drive orders & funders	
Funder/ Buyer		New product forecasts drive funding projections	New product forecasts drive short-term funding	Country forecasts drive disbursements	Country forecasts drive disbursements
Global Program		New product forecasts drive funders, approvals	Country forecasts drive funders, approvals	Country forecasts drive funders/ suppliers	Country forecasts drive funders/ suppliers
National Program/ Country Buyers		Country forecasts drive budgets & regulations	Local forecasts drive budgets, regulations & supply chains	Local forecasts drive orders & logistics	Local forecasts drive orders

Given the importance of forecasting and how many stakeholders would benefit from better forecasts, it is initially surprising that forecasting is seen as such a problem in global health: why hasn't this been fixed? Part of the explanation can be found in the fact that the major changes in funding, products and other factors are relatively recent, and there has not yet been a corresponding improvement in forecasting methods or institutional roles. However, that is only part of the explanation. The rest can be found in the fact that within the current market, risks are unequally distributed across key actors whose decisions affect supply of and demand for products; as a result, not all stakeholders face incentives that are aligned toward the aim of better forecasts and greater access to critical medical technologies. Moreover, because of the limited market potential in developing countries, there is little investment by the private sector in market research and other sources of information that are common in developed markets. Understanding and strategically correcting the misaligned incentives is a core challenge, explored in Chapter II.

II. RISKS AND INCENTIVES IN THE VALUE CHAIN FOR ESSENTIAL HEALTH PRODUCTS

The two-way relationship between demand forecasting and risk is clear: First, because major risks are inherent to both the supply of and demand for health products, particularly in the developing world context, accurate forecasting is difficult. Second, weaknesses in demand forecasts exacerbate risks to those who are selling and buying products, and/or preparing for future engagement in the market. So it's useful to start an examination of how to improve demand forecasting with an analysis of the sources of risk and the distribution of risk across the players in the global health market. In doing so, we can see that improvements in demand forecasting depends on progress toward better sharing risk and aligning incentives among those who influence market dynamics.

This chapter begins with a description of common risks in the market for critical medical technologies, with particular attention to the developing country environment. It then discusses how those risks are distributed across actors, and the consequences for access and forecasting.

A Way to Look at the Risks

For medical products, the nature of the market and the way the value chain from R&D to consumer functions – or fails to function – can be understood in part by identifying a set of common risks. Each of the underlying risks affects the ability of main actors (including suppliers of raw and finished products, intermediaries, consumers and others) to make economically efficient decisions and ensure products are available in the quantity, quality, place and at the price that would yield maximum health benefits. In particular, the risks affect the ability to make an accurate prediction about the future size and features of the market.

There are as many ways to describe and classify risks as there are economists or supply chain experts doing it. While not exhaustive, the list below illustrates one way to identify the core risks that affect the supply of products, demand for products, entry into the market related to regulatory factors and logistics of delivering products. In the descriptions below, key issues related to developing country settings are highlighted.

On the ***supply side***, risks are associated with the development and manufacture of the product, including;

- R&D risk: The transition from investments in the basic scientific discovery process to the viable molecules that merit clinical studies, and then the "survival" of those products through the phases of clinical studies, is fraught with uncertainty. To some extent, the ambition of the product development public private partnerships is to reduce this risk by diversification: funding multiple scientific pathways to address a complex challenge, as in the search for malaria, TB or AIDS vaccines, drugs, diagnostics and microbicides. In the absence of public or charitable subsidies, individual manufacturers bear this risk.
- Batch yield/Production yield risk: A firm may produce batches of products that fail tests for effectiveness, uniformity or safety due to a failure in a process, component, system or because of personnel error. Products with relatively short production track records are particularly vulnerable to this type of risk, which is typically borne exclusively by the manufacturer.

- Input risk: A firm may face an inelastic supply of inputs required for the finished product, such as raw materials or active pharmaceutical ingredients. This is a particularly acute concern for products like ACTs, where production requires active ingredients from agricultural materials, which themselves are subject to a host of weather, market and other risks.

On the ***demand side***, multiple risks exist. These are related to the likelihood that a product will be wanted by those who might place orders, and the ability to translate a desire for the product into orders to suppliers. Major risks include:

- Competition risk: Some products benefit from a temporary period of exclusivity through intellectual property protection and others face little competition because of the complexity of production or regulatory barriers. But where there are alternative products that yield health benefits, the price and availability of those substitutes can make a significant difference to demand for the company's product.
- Obsolescence risk: A long-term risk for some products is that they are rendered obsolete. For example, a better alternative may be developed, or the need for a product may be eliminated or greatly reduced because of existence of entirely new class of products for the same condition (e.g., treatment replaced by vaccine), or underlying risk factors may change (e.g., less need for treatment for diarrheal disease if water and sanitation is improved). This is a particular problem if manufacturing assets are specific to a given product that becomes obsolete.
- Policy and preference risks: Adoption and post-regulatory approval of medical technologies frequently depends on a range of uncertain determinants, such as the availability of data about the burden of disease, public attitudes to the disease, understanding of the range of interventions, and stigma and understanding about a particular product or intervention. Whether or not a country decides to adopt a new technology or therapeutic after regulatory approval into a national disease control program is a significant risk, which can be further amplified by a lack of clarity at the country level on how such decisions are made and how long it would take to roll out a new technology, if adopted.
- Budget and purchasing power risks: Volatility in donor budgets for global health lead to unpredictable demand (see Chapter VI). Furthermore, if developing countries pay for some or all of the costs (for example through a co-financing mechanism) uncertainty about domestically financed health also affects demand. This risk category also includes the possibility that funding aimed at product purchase is diverted, through legal or illegal means.
- Credit risk: A borrower, supplier or customer might fail to honor its contractual obligations. In the pharmaceutical market, this may be quite pronounced if the contractual obligations are weakly enforced – again, a feature of developing country markets.
- Price-related risk: Key decisions are made based on particular assumptions about near- and long-term prices. These decisions are taken with a knowledge that these may play out differently than expected – for example, because large purchasers are in a stronger negotiating position than anticipated, and bargain down prices – but without information about what the actual dynamics will be.

Regulatory and quality assurance factors also convey significant risks – all the moreso in developing country environments, where the role of regulatory agencies may be less well defined, have a shorter track record than in advanced markets, and be less predictable.

- Regulatory and post-regulatory regime risks: Regulatory regimes change in unpredictable ways; this may include new requirements concerning manufacturing processes, changes in intellectual property regimes and other factors.
- Regulatory enforcement risks: Where enforcement of regulations is weak and/or changing quickly, there is the risk that poor quality and/or counterfeit products will enter the market and crowd out good quality and/or branded products.

Finally, a set of major risks associated with ***logistics*** affect decision making, particularly in developing country environments. These include:

- Non-timely delivery: These are risks associated with unforeseen weaknesses and bottlenecks throughout the supply chain, including transportation breakdowns, leading to stock-outs.
- Losses in distribution chain: Waste due to leakage or lack of appropriate storage (e.g., breakdown of cold chain), if not predicted in placing orders, can imply risks.
- Complementary inputs: Human resources, accompanying products (e.g., testing kits needed prior to some treatments, injection supplies), or other inputs may not available in the required quantity and location to make use of product. This may occur, for example, if scale-up of services occurs rapidly, and there is an inadequate ability to respond with newly trained or deployed personnel, vehicles or other complementary inputs. It may also occur if orders are placed without bundling complementary products, such those for testing and treatment.

Consequences of the Risks

The consequences of each of these core risks can be played out individually, but the importance lies in the overall scenario wherein these risks are manifested in one or more of the following outcomes, which themselves imply risk for the health of those who are unable to obtain needed products and the financial well-being of firms producing goods and services.

Mortality/morbidity: Shortages of products can result in the hard-to-observe phenomena of diseases not prevented – for example, when vaccines are not available – and the easier-to-observe problem of drug stock-outs. This is of particular concern when interrupted treatment quickly worsens a disease process (as for antiretrovirals in the treatment of AIDS), and/or creates the risk of drug resistance (as for TB, malaria, AIDS and other viral and bacterial conditions).

Inefficient use of financial resources: Firms may manage many of the risks by keeping prices higher than they would otherwise be, to buffer the consequences of being left with unsold inventory or encountering other situations that have negative financial implications. Although firms have, in the main, made an effort to keep prices as low as possible for developing country markets – typically as part of corporate social responsibility efforts – they rarely are able to permit engagement in developing country markets to operate in a money-losing position over the medium- or long-term. Thus, when products are supplied, given the risks encountered in the developing world market and

supply chain, they may be at higher prices than would be the case if less risk were present. Donor, national government and private monies do not go as far as they otherwise would.

Excess inventory: If the suppliers' estimates of short-run effective demand are incorrect – for example, if orders that are expected do not materialize, or national programs' uptake of new products is slower than hoped – then the supplier is left with excess inventory, and the resulting financial losses. This has consequences for the health of the business. For example, GAVI initially estimated the amount of hepatitis B vaccine that would be required based on available funding and epidemiological projections. Several manufacturers, particularly in India, scaled up production or entered the market to accommodate these demands. However, uptake of the vaccine was much slower than predicted and so the price dropped almost 80%, causing some developing country manufacturers to go out of business and making many others nervous about future investment.

Long-term overcapacity: If a supplier's estimates of long-run effective demand are incorrect – for example, if competing technologies are licensed earlier than anticipated and capture part of the demand – then the supplier is left with excess manufacturing capacity, and potentially costly unnecessary supply agreements with firms providing key inputs. This has negative financial consequences for the supplier.

Shortages: If the supplier underestimates demand, or if the supplier has difficulty obtaining inputs or suffers batch failures, then supply can undershoot demand. If prices are not fixed, they will rise and only purchasers who can pay those higher prices will be served; if prices are fixed, the shortage will be felt across the board. This has negative financial implications for the purchaser and, more importantly, important health consequences – unprotected populations and untreated individuals. In addition, the supplier may suffer reputational injury from being unable to supply life-saving or life-extending medications.

Lack of investment in next-generation products: The functioning of the value chain, and the rewards that engagement in the value chain confers upon both suppliers and donors, strongly influences their interest in R&D. If, for example, pharmaceutical firms face extremely high transaction costs in supplying the developing world and uncertainties around effective demand result in financial losses in absolute or relative terms, their appetite for developing new products for that market will be weak. On the side of donors, if inefficiencies in the existing value chain result in relatively high prices or poor access to products because of weak value chains, the ability to mobilize more funds consistently over the long term is jeopardized. Moreover, investment in the public-private partnerships that are now seen as important to development of products for the developing world can only be mobilized if current and near-term products are effectively moved into the market and into well functioning distribution channels.

Those Who Bear the Consequences Cannot Reduce the Risks

Some of the risks described above are unavoidable. However, at least in concept, many others could be avoided or reduced by actions of buyers, sellers or intermediaries. For example, policy and preference risks are reduced when regulatory and post-regulatory bodies are transparent about the criteria used for decisionmaking and give sufficient notice about when they are likely to take a particular decision that has implications for the market. Budget risks are reduced when funders commit to a particular funding stream, under transparent rules, over a multi-year period. Risks

related to the entry of new products are reduced if awareness about the size and characteristics of the potential market drives decisions about the publicly-subsidized product development pipeline. Risks associated with logistics and distribution are reduced when those who were responsible for operating and strengthening the supply chain make sufficient and well-organized investments in its smooth functioning. Clearly, these changes represent parts of a long-term agenda to develop a better functioning market for global health products that is underway, but in an early stage.

In the global health environment, actions to reduce risk have not systematically been taken in the past – in large measure because ***those who experience and suffer the consequences of the risks are not those who are in a position to reduce them***. Under current arrangements, most of the consequences are felt by two parties: First, manufacturers, who face the possibility of short-term excess inventory and long-term overcapacity, and/or the reputational damage when they are seen as responsible for shortages; second, patients and communities in developing countries, who are insufficiently protected against the potential lack of access to products, stock-outs or products that should be on the shelf, poor quality products and other conditions that jeopardize their health. The consequences are felt only indirectly by the funders and intermediaries who could take specific actions to reduce the underlying budgetary, policy-related, and logistics risks.

The situation is particularly pronounced because so many of the parties who are in a position to reduce risks – including bilateral and multilateral funders, public-private partnerships, specialized organizations that undertake procurement such UNICEF, international regulatory and post-regulatory authorities like WHO, and national buyers – are understandably subject to a set of organizational imperatives that may conflict with taking actions to reduce risks. In agencies providing funding for the purchase of global health products, for example, decisionmakers may be responsive to the need to show success in negotiating low prices, or disbursing funds only to "well-governed" nations, or maintaining year-to-year flexibility in setting priorities for the use of scarce resources. In organizations that support product development with research grants, success may be measured by the number of products in the pipeline rather than the viability of the resulting market for manufacturers that may supply products over the long term. Despite the potential health-related value of expanding the range of products and suppliers, procurement agents may face unwelcome costs associated with building relationships with multiple suppliers, creating information interfaces, evaluating numerous bids and administering multiple contracts. Agencies that have a role in product regulation and quality assurance may be extremely averse to implementing any acceleration or change in procedures that could increase the risk of a quality lapse, even very slightly. National buyers and health authorities may face uncompensated costs if they choose to introduce new products, and thus may rely upon older, less effective therapies.

While many of these challenges exist to some extent in developed-world markets as well, historically higher levels of health spending have allowed manufacturers and buyers to develop and use responsive, higher-capacity supply chains and excess inventory to buffer against market uncertainties.[a] Developed markets are also characterized by relatively good information and market research, in part because more money has been invested for information gathering. Purchasers and suppliers also have established relationships and balanced market power.[23] Both formal and informal risk-sharing is a common feature of market relationships in developed countries.

[a] However, the use of excess inventory has become more restricted even in developed markets as a result of the U.S. Sarbanes-Oxley legislation, which prevents drug companies from producing inventory above forecasts to counter "dumping" in the market.

Developing country markets are rapidly evolving and much more complex. Data are limited and unreliable, few tools exist to gather good market research, and both money and human resources are in shorter supply. At the same time, disaggregated and small purchasers combined with multiple layers of international and national decision makers make the process more uncertain and expensive for manufacturers and buyers. In addition, health goods are delivered by multiple supply chains including public, non-profit or NGO, formal private and informal sector. Given this situation, it is unrealistic to expect manufacturers and private intermediaries to make significant investments in the information and supply chain infrastructure that could help to reduce and manage major sources of risk, and contribute to better demand forecasting.

What Lopsided Risks Mean for Forecasting

In a well-functioning supply chain, where risks are shared across stakeholders, all parties have an incentive to contribute to keeping a flow of funds, information and products moving efficiently. It is a feature of the market, in fact, that mechanisms (typically contracts) are employed to distribute risks – say, between retailers and wholesalers – so that they have incentives to take actions that reduce overall risk and make it more likely for products to move efficiently to customers. In short: When risks are distributed so that each party is made better off through collaboration, that collaboration is likely to occur. In contrast, as is the case for the current arrangements for global health products, risks are not broadly distributed across actors, and individual funding agencies, regulatory bodies, firms and intermediaries are less likely than they otherwise would be to work together toward the common goal of access. More narrowly, the misalignment in incentives may interfere with the aim of obtaining aggregate demand forecasts that are as accurate and credible as possible.

To understand how this works in practice and what might be done to correct some of these misalignments, the Global Health Forecasting Working Group commissioned a risk and incentive audit of the global health supply chain through the MIT-Zaragoza Center for Supply Chain and Logistics Management, conducted by Dr. Prashant Yadav. The objective of the audit was to use expertise from the field of supply chain management to assess the current allocation of risks in the value chain for global health products and its impact on the incentives of different stakeholders.

Because supply chains are product-specific, an audit of risks and incentives must also be product-specific. The risks and incentives audit commissioned by the Working Group mapped the ACT supply chain and concentrated on the externally funded, public sector procurement of ACTs. Due to the complexity and specificity of each country level supply chain, this study focused only on the global actors in the supply chain and did not map the risks and incentives within each country or those faced by the ultimate consumers-patients. Expanding the study to map individual country public and private supply chains could be a further piece of work that would provide a more complete picture of how ACTs reach patients, and the specific risks and incentives faced by local stakeholders.

ACTs were selected because they are the newest drugs in the arsenal against malaria and their recent problems with supply and demand have been well publicized. The fight against malaria is also garnering significant donor funds over the next few years, making it critical that underlying incentive misalignments are addressed quickly so new monies yield maximum impact.

While the detailed findings from the audit are specific to ACTs, the risks and incentives identified and the methodology developed provide a tool to better understand incentive misalignments for other health products.

The ACT Supply Chain[24]

In view of the World Health Organization's recommendation of the use of ACTs for first-line treatment of malaria, the analysis which follows has focused exclusively on the ACT market of anti-malarials as a case study. The authors and Working Group recognize the important market share currently held by older classes of drugs and artemisinin monotherapies that are used to treat malaria fevers. This importance of this sector adds to the complexity of overall demand forecasting and risk management for suppliers of anti-malarial medicines. For the sake of clarity in highlighting some of the issues, the case study has been limited to ACT products rather than all anti-malarials currently sold in malaria endemic countries.

The Disease and the Problem

Incidence and prevalence of malaria are difficult to quantify because it is a disease that often goes unreported and untreated. Estimates on the number of people affected by malaria vary significantly, from 300 million to 660 million cases annually.[25] Some studies report more than 1.2 million deaths each year from malaria, most of them children under the age of six.[26] The health and economic toll due to malaria is tremendous; Africa alone loses U.S. $12 billion annually in direct and indirect costs from this disease.[27]

Proven methods exist to prevent and treat malaria and, potentially, eradicate the disease in many areas of the world. In the past 50 years, a variety of inexpensive anti-malarials, most notably, chloroquine, have been used for treatment, but a high degree of drug resistance has emerged during the past 20 years against this drug in many of the most severely affected countries. As a result in 2003, the WHO recommended artemisinin-based combination therapy (ACT) as the preferred malaria treatment in many countries. This is a relatively new class of drugs, and as of December 2006, Novartis which sells the drug under the brand name Coartem, was the only WHO approved manufacturer for a fixed dose combination ACT.

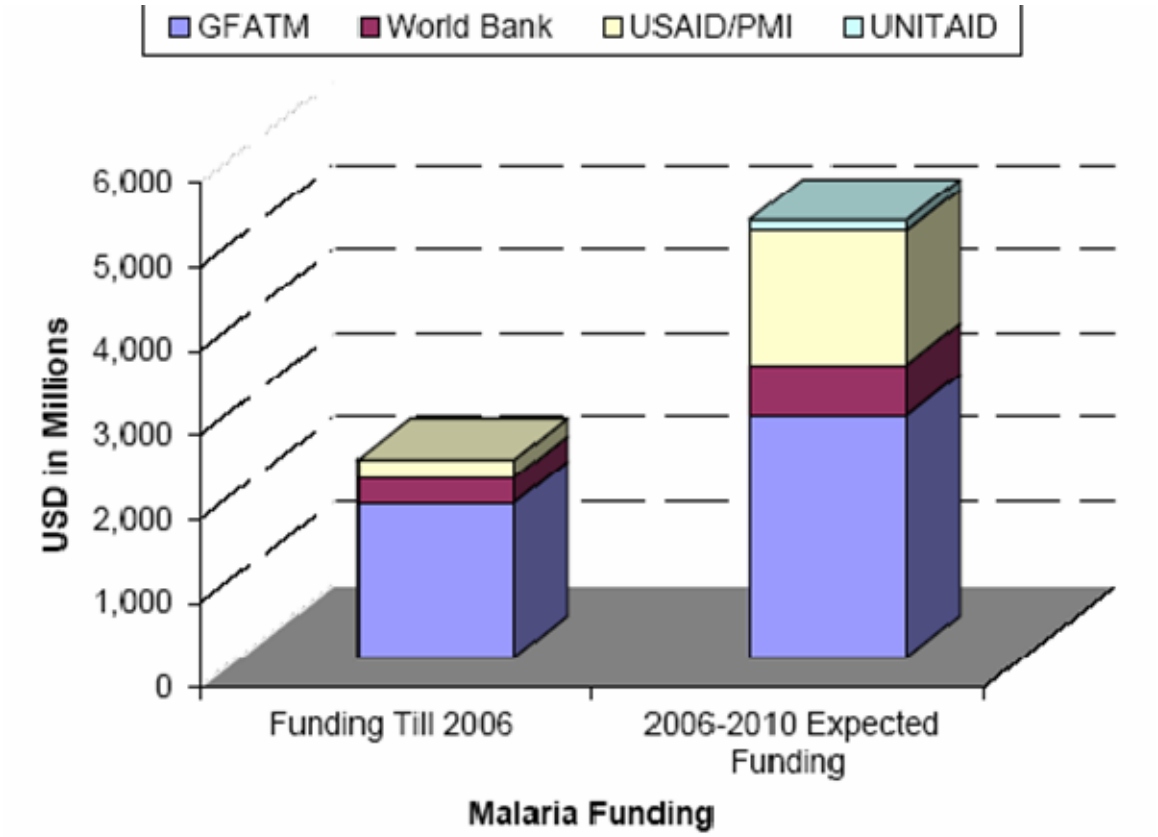
The costs of production and hence price, of Coartem and ACTs in general are significantly higher than traditional malaria treatments: 10 cents for an average dose for chloroquine compared to $1 for Coartem in the public sector;[b] private sector prices range from $12-15 per dose.[28] The high costs of ACTs are based on a number of factors including a long production cycle dependent on the agriculture production of a key API, artemisinin. Because of its price, affected countries are presently unable to cover the costs of ACTs without external resources, and increasingly rely on donors to fund malaria treatment programs. By far the largest funder of ACTs is the Global Fund, which finances 60-70% of all externally funded demand worldwide, followed by the World Bank, the President's Malaria Initiative, and UNITAID (see Figure 2.1). The long production cycle of ACTs coupled with a very short shelf life of only 24 months make the need for accurate demand forecasts essential. Unfortunately, Coartem demand forecasts have been notoriously unreliable, resulting in shortages in 2004 followed by large surpluses and excess inventory in 2005 and 2006.[29] Today, while

[b] Public sector prices effective September 2006

Novartis has scaled-up its production capacity to produce 120 million treatments (based on the WHO initial forecast in 2004), the realized sales continue to be in the range of 60 million treatments.

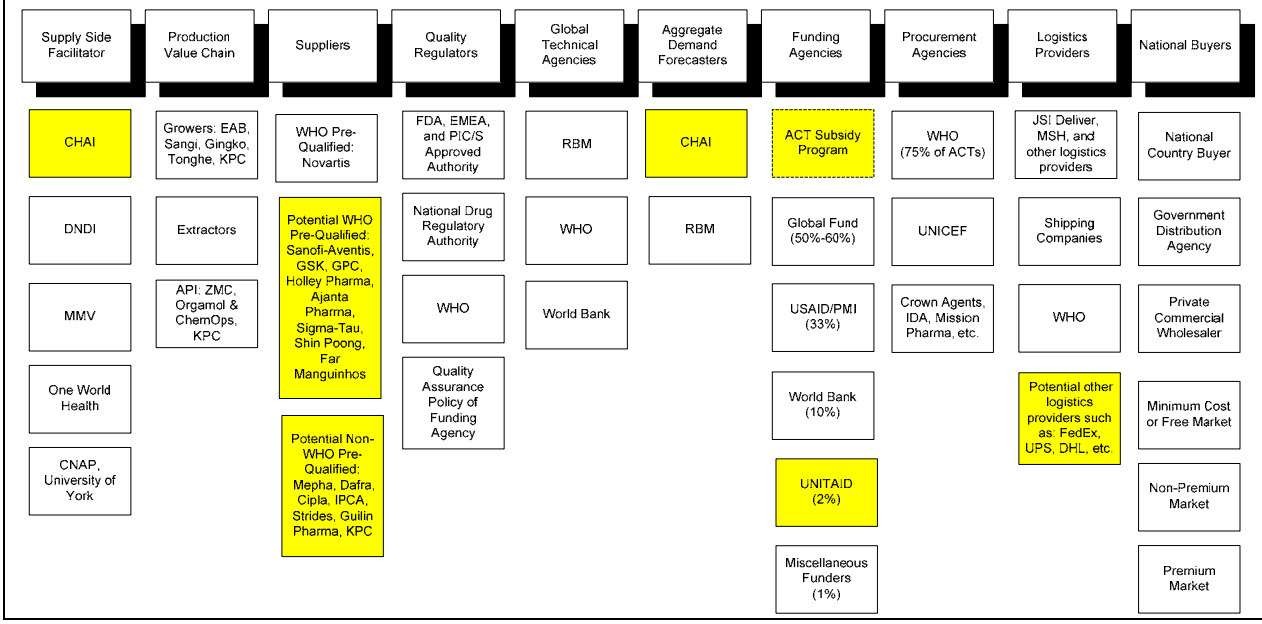
Some argue that this mismatch between supply and demand is a temporary consequence of the creation of a new market. But the situation over the past few years has been relatively simple, characterized by essentially one large funder (the Global Fund), one WHO approved supplier, Novartis, and one procurement agent, the WHO, which negotiated prices with Novartis and has served as the only authorized procurer for public sector purchase of Coartem.

Figure 2.1 Historical and Projected Levels and Sources of Malaria Funding (Sources: Global Fund, USAID, World Bank and UNITAID)



An analysis of the ACT market shows that the landscape is rapidly becoming much more complex, with many more manufacturers entering the ACT market, a diversity of new funders, and several new procurement agents who will be able to procure the drug on behalf of countries (see Figure 2.2). With these additional choices comes greater uncertainty in demand and supply, making forecasting even more challenging and increasing the risks for individual suppliers and buyers. The highlighted boxes in the chart below identify the new players expected in the future ACT supply chain.

Figure 2.2 Projected Stakeholder Map of the ACT Supply Chain



Who Bears the Risks in the Supply Chain for ACTs?

The way in which risks and rewards are shared among stakeholders in a supply chain determines its effectiveness, efficiency and long term sustainability. A poor allocation of risks leads to misaligned incentives, which in turn lead to behavior by individual stakeholders that compromises the effectiveness of the entire system.

The various types of risks in global health markets described in Chapter II are all clearly manifested in the ACT supply chain. Some of these risks are financial and quantifiable (e.g. cost of long term overcapacity, holding excess inventory), while others are more qualitative (e.g. reputational risk).

There are also several layers of risks. Some are underlying risks, such as batch failure, while others are *consequences* of underlying risks, such as supply shortages caused by production risks, budget or purchasing power risks, or preference and other demand risks. Each risk affects the behavior of the stakeholder that bears that risk. Appropriate allocation of risk means that stakeholders who can in some way mitigate or manage the risk, bear some of the costs (financial and other) for that risk. Based on interviews with key stakeholders, the major risks in the ACT supply chain (Figure 2.3) and how they are allocated, are mapped below.

The risk allocation map can be read in several ways: looking across the rows shows the extent to which each stakeholder bears some of that particular risk. Looking down the columns gives a picture of which stakeholders are bearing the greatest risks across the spectrum. The darker the square, the more a particular risk is borne by that stakeholder. For example, suppliers bear the greatest burden of financial risks for excess inventory because under current contracting arrangements they do not receive purchase commitments, but must have inventory available to fill orders as they are placed. National buyers bear some risk for excess inventory if they order too much and products sit past

their shelf life in warehouses; while funding agencies bear a lesser, indirect risk if their monies are ineffectively used when national buyers over-order, resulting in wastage at the country level.

Figure 2.3 ACT Risk Allocation Map

No risk | Moderate Risk | Low Risk | High Risk

	Supply Side Facilitators	Suppliers	Quality Regulators	Global Technical Agencies	Aggregate Demand Forecasters	Funding Agencies	Procurement Agents	Logistics Providers
SUPPLY-SIDE RISKS								
Batch Yield Risk		Low Risk						
Excess Inventory Risk								
Financial		High Risk				Low Risk		
Reputational					Low Risk			
Long-Term Overcapacity Risk								
Financial		High Risk						
Reputational	Low Risk				Low Risk			
Shortage Risk								
Financial		Moderate Risk						
Reputational		High Risk		Low Risk	Moderate Risk	Low Risk		
DEMAND-SIDE RISKS								
Price Increase						Moderate Risk		
Price Decrease		Moderate Risk						
Grant Approval & Disbursement Timing Risk		High Risk				Moderate Risk		
Sustainability of Funding	Low Risk	Moderate Risk				High Risk		
REGULATORY AND QUALITY RISKS								
Counterfeit product		Moderate Risk						
Safety of approved drugs		High Risk	High Risk			Low Risk		
Lack of approved drugs			Low Risk					
LOGISTICAL AND MISCELLANEOUS RISKS								
Non-timely delivery		Moderate Risk					Moderate Risk	Moderate Risk
Losses in the distribution chain						Low Risk		
Asset specificity due to early adoption								
Risk of success(vaccine, eradication etc.)	Low Risk	Moderate Risk						

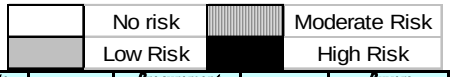
Looking at the map by stakeholder shows that most of the risks in this supply chain fall to suppliers. National buyers also bear risks with the most acute one being dependence on donors for sustainability of funding. Risks can also be lopsided; for example, quality regulators are at much higher risk if drugs they approve turn out to be unsafe than if drugs are not moved quickly through approval processes.

The ACT supply chain shows significant scope for better risk sharing between stakeholders. For example, funding agencies bear very little risk in the developing country supply chain, unlike funders in developed markets who share risk with suppliers through purchase guarantees and other contracting mechanisms.

By contrast, Figure 2.4 maps risk in a representative pharmaceutical value chain in the United States. In addition to fewer stakeholders, it is clear that risks are more evenly distributed. For example, financial and reputational risks for shortages are borne by suppliers, procurement agents (wholesalers) and buyers (e.g. pharmacies, hospitals) because wholesalers and buyers negotiate

binding purchase contracts with suppliers. The same is true of excess inventory risk, where both wholesalers and buyers share in the costs of holding inventory.

Figure 2.4 U.S. Pharmaceutical Risk Map



	Supply Side Facilitators	Suppliers	Quality Regulators	Aggregate Demand Forecasters	Funders (Insurers)	Procurement Agents (Wholesalers)	Logistics Providers	Buyers (Pharmacies,Hospitals)
SUPPLY-SIDE RISKS								
Batch Yield Risk								
Excess Inventory Risk								
Financial								
Reputational								
Long-Term Overcapacity Risk								
Financial								
Reputational								
Shortage Risk								
Financial								
Reputational								
DEMAND-SIDE RISKS								
Price Increase								
Price Decrease								
Grant Approval & Disbursement Timing Risk								
Sustainability of Funding								
REGULATORY AND QUALITY RISKS								
Counterfeit product								
Safety of approved drugs								
Lack of approved drugs								
LOGISTICAL AND MISCELLANEOUS RISKS								
Non-timely delivery								
Losses in the distribution chain								
Asset specificity due to early adoption								
Risk of success(vaccine, eradication etc.)								

If suppliers are expected to provide their products at low or zero margins, and guarantee access to products when and where they are needed, it is important that funding agencies and other stakeholders share some of the risks that suppliers are currently bearing. In the long run, stakeholders who bear disproportionate risk but are not adequately compensated will either leave the market or engage in behavior that will threaten the viability of the value chain.

And Where Are the Incentives?

The extent of the risks borne by each party, and whether their distribution is lopsided, can lead to misaligned incentives in the supply chain. The goal of the ACT supply chain is to provide access to products. The incentives map (Figure 2.5) shows whether each stakeholder has a definite incentive, a clear disincentive or neither one, to engage in a particular behavior that will promote this goal. In and of itself it is not "good" to have a positive incentive and "bad" to have a disincentive; this depends on how the incentive, disincentive, or lack of incentive affects the overall goal of access.

Major misalignments in the supply chain are highlighted. The map shows misalignments in several areas of forecasting. In the case of long-term capacity forecasts, suppliers' incentives are balanced: they have a disincentive both to over-forecast and to under-forecast because, as illustrated in the risk

map, they bear the costs of overcapacity but must have sufficient inventory for orders. On the other hand, the incentives faced by national buyers for long-term capacity forecasts are lopsided: they have an incentive to over forecast so they can guarantee capacity from the supplier, but no incentive to under forecast (which would result in more accurate estimates of demand) because they bear no risk for overcapacity.

Figure 2.5 ACT Supply Chain Incentives Map

Disincentive	↓	Indifferent	-
Incentive	↑	Potential Misalignment	

	Supply Side Facilitators	*Suppliers*	*Quality Regulators*	*Global Technical Agencies*	*Aggregate Demand Forecasters*	*Funding Agencies*
SUPPLY-SIDE						
Develop Innovative Products	↑	↑	-	-	-	-
Increase size of the supply market	↑	↓	-	↑	-	↑
Decrease supply chain lead time	↑	-	-	↑	-	-
Overforecast in the Short-Term(< 12 months)	-	↓	-	-	↑	↑
Underforecast in the Short-Term(< 12 months)	-	-	-	-	↓	↓
Overforecast in the Long-Term (1-5 years)	↑	↓	-	↑	-	↑
Underforecast in the Long-Term (1-5 years)	↓	↓	-	↓	-	↓
Sharing Information on demand, inventory…	↑	↓	-	-	↑	-
DEMAND-SIDE						
Decrease wholesale price of ACTs	↑	↓	-	↑	-	↑
Decrease retail or end-customer price of ACTs	↑	↑	-	↑	-	↑
Expedite grant approval and disbursement	-	↑	-	-	-	↑
Rapid adoption of ACTs as a treatment option	↑	↑	-	↑	-	↑
Enhance the level and sustainability of funding	↑	↑	-	↑	-	↑
REGULATORY AND QUALITY						
Ensure regulatory compliance and safety	↑	↑	↑	-	-	↑
Expedite regulatory approval of new drugs	↑	↑	-	↑	-	↑
LOGISTICAL AND MISCELLANEOUS						
Improve efficiencies in distribution chain	-	-	-	↑	-	↓
Ensure availability of complementary inputs	-	↓	-	↑	-	↑
Achieve long lasting success(eradication)	↑	-	-	↑	-	↑
Have rigorous accountability in funds usage	-	-	-	-	-	↑

There is a similar mismatch for short-term forecasting. In this case, manufacturers have an incentive to under-forecast because they bear the costs of holding excess inventory, while others in the supply chain, such as funding agencies, procurement agents and national buyers, have an incentive to over-forecast because they have very limited risk for excess inventory but wish to guarantee sufficient availability of product. Experience in other industries shows that if forecasts are successively inflated, they will be ignored by suppliers, resulting in less supply rather than over production.

To more accurately match supply and demand, stakeholders should have balanced incentives for under- and over-forecasting. This would be achieved through more evenly sharing forecasting risk among key stakeholders.

Another critical area of misalignment that affects forecasting is sharing supply and demand information, which serves as inputs into forecasts (such as buyer intentions, inventory levels, etc.). The map shows there is no clear incentive for most players to share this information with others in the supply chain because they bear no risks for poor forecasting. Individual suppliers have a disincentive to share supply information if it can identify supplier-specific inventory and production capacity, because it could give an unfair advantage to competitors. However, if the information is shared in aggregate and without attribution, the supplier's disincentive to share this information is removed. As will be discussed in Chapter IV, to share forecasting information which will lead to more accurate long and short-term forecasts requires that these misalignments be corrected.

Other areas of incentive misalignment show that national buyers lack clear incentives to rapidly adopt new therapies, such as ACTs, because they bear the switching costs from older therapies, even through donors may provide the drugs free of charge. They also do not necessarily benefit by reducing the retail price of ACTs (e.g. by providing ACTs free at the point of treatment) if they rely on cost recovery to fund the health systems delivery capacity. If widespread adoption of ACTs at free or affordable prices to patients is a public policy objective, then these misalignments need to be addressed.

The misalignments described above, and their consequences, are pronounced in the case of ACTs; but this is not unique. The structural complexities of the global health market, including the number of instances in which one agency (e.g., a funder) is acting on behalf of another (e.g., a Ministry of Health) through a third (e.g., a procurement agent), combine with the asymmetrical distribution of risk to create major problems for forecasting and for access to medicines.

It is against this backdrop that solutions must be found to the challenge of forecasting demand. The overview of the major risks within the global health market, and their asymmetric distribution, provides the starting point for the long-term agenda: more predictable funding; more efficient and transparent regulatory and post-regulatory regimes; attentiveness to the impact on the market of new products in the pipeline; and a stronger supply chain all the way to the patient. It also provides the foundation for nearer-term approaches to correct misaligned incentives that impede forecasting and access: (a) taking forecasting seriously, as a core element of the supply chain for global health; (b) adopting strategies to share information more systematically; and (b) reducing overall market risk and better sharing the remaining risks in the market through more effective contracting methods. These are the subject of the following three chapters.

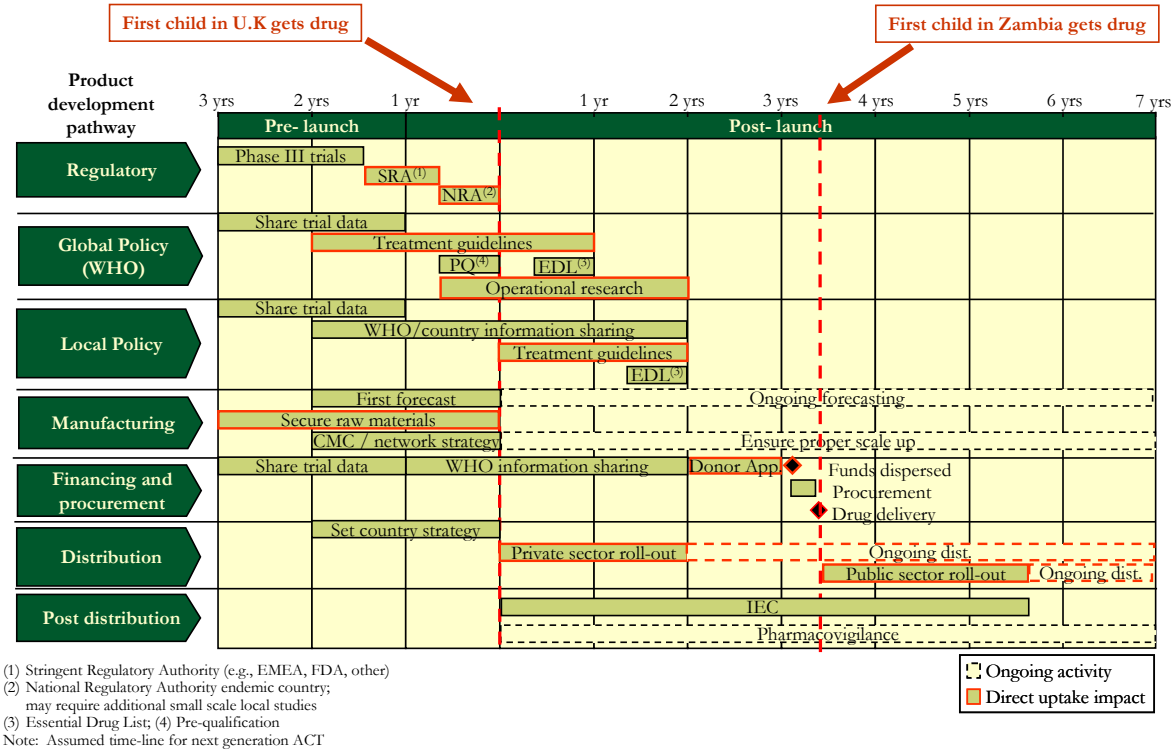
Box 2.1 Contrasting Supply Chains in Developed and Developing Markets

One example of the additional risks faced in developing country environments can be observed in the different experiences of a child in the UK and in Zambia attempting to navigate the market for critical medical technologies (in this case, for malaria treatment). The sad consequence is that the Zambian child must wait three years longer than her British counterpart to get access to this life-saving treatment, even when the money is available (see Figure 2.6).

If a child living in the UK fell ill with malaria, she would be assured that the major producer of ACTs, the preferred drug for malaria, would have registered her drug with the regulatory authorities and received approval for its use. In most cases, the drug would have also been authorized by the National Institute of Clinical Excellence for the treatment of malaria. She would have the confidence that when she went to her doctor, the doctor would prescribe the drug and it would be paid for by the National Health Service (NHS). If she was in the hospital, availability would not be a problem because it would have been

procured on the basis of demand forecasts and framework contracts by the NHS Purchasing and Supply Agency and delivered to her hospital directly by the manufacturer or DHL, the logistics provider for the NHS. If she was not in the hospital, she would be able to go to her local pharmacy and obtain her drug, with the bill being paid directly by the NHS.

Figure 2.6 Public Sector Roll Out of New Malaria Products (Source: Boston Consulting Group for Medicines for Malaria Venture)



(1) Stringent Regulatory Authority (e.g., EMEA, FDA, other)
(2) National Regulatory Authority endemic country; may require additional small scale local studies
(3) Essential Drug List; (4) Pre-qualification
Note: Assumed time-line for next generation ACT

By contrast, if the same child lived in Zambia, the necessary drug may not yet have received approval for use in her country if it had not passed WHO prequalification as well her government's own national registration processes. This could be because the manufacturer had not chosen to get the drug registered, or it could be because the drug was waiting in the queue for various approvals, which can take from two to three years; or it could be that the drug was not on the WHO accepted treatment guidelines and essential drugs list which are created by two separate processes. Or if it had been approved by the WHO, it might still not be on her national essential drugs, which would be required before it could be ordered through the public sector.

If the drug had been through all of these approvals, and was also on the required treatment guidelines and essential drug lists, then she would hope that her national health system had ordered the drug and it was available in stock. But her drug may not have been ordered because there were problems with donor funding, problems with approval for accessing the funds, poor forecasting of the demand for her drug, or long delays in procurement because of outdated and slow procurement procedures. Even if her drug was available in the country, she could not be assured that her drug had made it to her clinic because it would have had to go through a long and complicated distribution and logistics system made even more difficult by poor roads and communication. (Appendix C describes these two supply chains in greater detail).

If our child in Zambia overcame all these hurdles to receive her drug where and when she needed it, it would save her life.

III. RECOMMENDATION 1: TAKE DEMAND FORECASTING SERIOUSLY

As Chapter I shows, good demand forecasting is essential to ensuring that medicines and other critical medical technologies get to the people who need them when they need them. In the past two years, several organizations have realized the need for accurate demand forecasting and invested resources to produce credible, aggregate forecasts. At the forefront of these efforts are the public-private partnerships responsible for ensuring that new products are developed for neglected diseases and that existing products reach the developing world. CHAI, PneumoADIP, IAVI, MMV, and Roll Back Malaria, among others, have invested in both developing demand forecasting technical skills and gathering critical information to improve forecasting accuracy.

While these are important steps, taking forecasting seriously requires that demand forecasting becomes imbedded in all global efforts to increase access to essential medicines and technologies. This requires:

1. A clear understanding of what we mean by "demand forecasting" and how it differs from advocacy and demand creation activities.
2. Universal adoption of basic principles for good forecasting.
3. Investing in technical forecasting capacity and creating models specific to forecasting for developing world health products.

Each of these is discussed below:

Forecasting Demand Versus Stimulating Demand

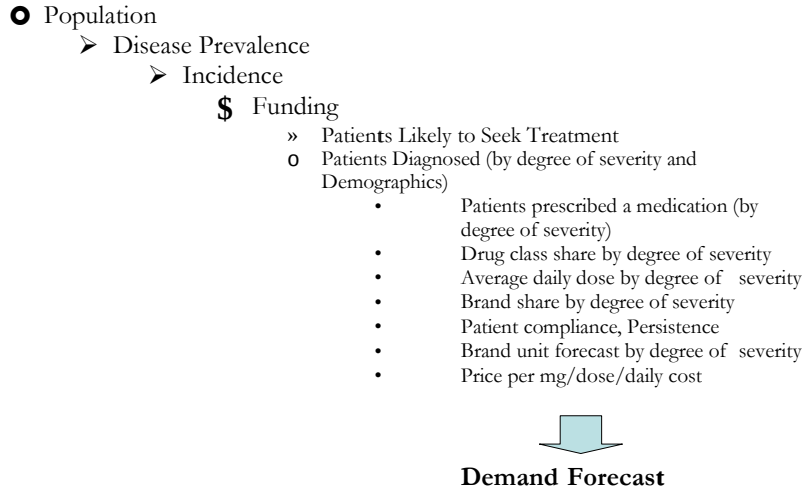
The term "*demand forecasting*" has often been used loosely in the global health community to define a wide range of forecasts that do not measure effective demand for health products (i.e. product needs which have or will have purchasing power behind them and can result in actual orders). For example:

- Within international agencies, the term demand forecasting is often used to mean "needs forecasting" – e.g. the number of people affected by a disease based on epidemiological data and the proportion of those requiring treatment.
- Funders may use it to mean "resource forecasting" to project needs for future financing, usually from the donor community.
- For country programs and buyers, it can mean short term orders at one end of the spectrum, to describing ambitious government targets at the other.
- In global health programs, it is often used synonymously with "demand creation," or *generating* demand for products that can be used to address public health challenges.

While all these forecasts are important, none describes demand forecasts. First, demand forecasts do not identify the *need* for products or resources. While disease burden, epidemiological projections, and projected resources are essential inputs into demand forecasts, good forecasts use these basic inputs and refine them to produce projections of likely effective demand in the market. For example, while it is important to know that there will be three hundred million malaria cases annually or that two billion dollars are committed to malaria control by various donor agencies over

the next two years, this is not sufficient for suppliers to scale up production. Suppliers must know which products will be purchased, in what quantities and when orders are likely to be received. Without this information mismatches between supply and demand are inevitable.

Figure 3.1 From Need to Demand (Source: IMS Methodology for Producing Demand Forecasts)



Second, forecasts are not plans or targets; plans tell us how the future *should* look or how we would want it to look and targets are goals used to motivate performance.[30] In contrast, forecasts tell us how the future *will most likely* look based on a realistic analysis of the best data and estimates available.[31] To keep these two processes distinct, pharmaceutical firms separate the functions of forecasting and marketing. Marketing and sales functions (which are analogous to demand stimulation in global health programs) have targets and operate at arm's length from the analysts who produce demand forecasts. While optimism may be the hallmark of target-setting, realism is the watchword of demand forecasts.

While the focus of this report is on aggregate demand forecasting, once a product reaches the market, country and local level forecasts will build up to produce aggregate demand forecasts. The benefit of aggregate forecasts at this stage of the product life cycle is to ensure that suppliers understand overall product required and can scale up production capacity to meet this demand at the global level. This will help to smooth the fluctuations in actual orders between countries. For example, if an aggregate forecast for the most common fixed dose combination ARV (3TC+d4T+NVP) shows that 100,000 doses will be needed in 2007, suppliers can plan to meet this overall demand even if the actual orders from Ethiopia exceed its forecasts and those from Uganda fall short.

These aggregate forecasts, however, still depend on accurate country-level forecasting, which in turn depends on a clear understanding of the local drivers and constraints of scaling up treatment. Investments are required within countries to better understand constraints, and build models that take into account the key drivers of local demand, such as physician and patient preferences, direct and indirect treatment costs to the patient, public and private health services capacity, distribution

channels and special relationships between distributors and providers, among others. A realistic picture of current demand, and the critical drivers and constraints on demand, are important for understanding the levers which can be used to stimulate demand for global health products.

Principles of Demand Forecasting for Global Health: Forecasting is a Process, not a Number

Credibility and transparency are essential to the forecasting process and the demand forecasts that it produces. Forecasts are intended to drive decisions and investments by suppliers, distributors, funders and others, but this can only occur if the forecasting process is independent, free from political interference, and separate from advocacy and target setting. Lack of credibility will cause those who need to make investments to discount forecasts, creating the potential for supply shortages and stock outs.

The diversity of organizations involved in the value chain, across numerous countries, covering various stages of a product's life cycle, using different methodologies, with different base datasets, makes it very difficult to provide one answer on "how to forecast." It is not possible, nor arguably desirable, to strive for a single or limited set of methods and sources for forecasting. It is, however, possible and necessary to reduce the variation in forecast outputs and increase the confidence of all players in the market with the accuracy of the forecasts produced.

Adopting transparent evidence-based principles for forecasting is a first step in increasing credibility in the forecasting process and, ultimately, in the forecasts themselves. Ten Demand Forecasting Principles are described below, which should be adopted by organizations projecting demand for global health products. These principles are adapted from a much longer list of "Standards and Practices for Forecasting," which have been tested in a variety of industries over the past decades. [32]

These fundamental rules are not a description of *how* to forecast; but describe how to design and manage good forecasting *processes*. As such, these Principles are applicable to forecasts at all stages of the value chain, the client-care cycle (e.g. prevention, cure, prolonged treatment) and the health program life cycle (e.g. planning, launch, expansion, scale-up, maintenance, re-supply, and graduation).

Outlining transparent and evidence-based principles for creating demand forecasts can help to reduce overall risk and uncertainty in the market, increasing the chances that supply better matches demand. Specifically, these principles are intended to:

- *Increase market understanding and credibility:* Assuring users of forecasts that standard and transparent practices are being used increases credibility in the forecasting process. Adopting a principles-based approach to forecasting also improves consistency in forecasts across the value chain, increasing the likelihood that all stakeholders will take appropriate actions based on the demand forecasts produced.
- *Better understand and mitigate system-wide risk.* Reduced variation and increased credibility can reduce overall market and value chain risks for each stakeholder.
- *Increase value for money.* A more confident market can make investment decisions in R&D, manufacturing plants, and distribution that are more likely to result in products closer to the quantity/price optima. In economic terms this should help in improving allocative efficiency.

The Demand Forecasting Principles are divided into three basic categories (see Appendix D for more detail):

Customer-Focused Principles identify how to ensure that forecasts will meet the needs of customers and have the greatest impact on the decisions they are intended to inform:

1. Identify the principal customers/decision makers of the forecast and clearly understand their needs.
2. Understand and clearly communicate the purpose of the forecast and the decisions that it will affect.
3. Create a forecasting process that is independent of planning and target setting.
4. Protect the forecasting process from political interference and ensure it is transparent.

Process- and Context-Focused Principles identify how to create a credible forecasting process and how to develop, present, and understand the forecast in relation to the overall market and public policy environment:

5. Embed the forecast into the broader environment taking into account market conditions, public policy, competitive forces, regulatory changes, health program guidelines, etc.
6. Create a dynamic forecasting process that continually incorporates and reflects changes in the market, public policy and health program capabilities.

Methodology- and Data-Focused Principles identify how to select the right methods for the nature of the forecast being developed and effectively incorporate qualitative and quantitative information:

7. Choose the methodologies most appropriate to the data and market environment. Obtain customers'/decision makers' agreement on the methodologies.
8. Keep the methodologies simple and appropriate to the situation. Don't introduce too much complexity, but include sufficient detail to address the level of investment risk and accuracy required.
9. Make forecast assumptions clear and explicit.
10. Understand data and their limitations. Use creativity and intelligence in gathering and introducing data into forecasts.

These principles are equally relevant for public programs and private organizations, but may be applied uniquely by different organizations. National and global health programs, for example, are integrated organizations in which demand forecasting is one part of the many activities that the program undertakes to generate and meet demand for health products. Though demand forecasting should be a separate and distinct activity in these programs, it will be affected by the program's policies, budgets, stakeholders, priorities, infrastructure, management and administrative systems, staffing, catchment areas, and client needs and behaviors. These should serve as inputs into the forecast and *not* be used to change the forecast once it has been developed. As these capabilities change, the forecast will change, providing an important feedback loop to health program managers.

While all of these principles are important, ensuring that the forecasting process is independent, transparent and protected from political interference cannot be over-emphasized. Once demand forecasts become a tool of political targets and agendas, their usefulness is severely compromised.

Strengthen Technical Forecasting Capability

Putting the Demand Forecasting Principles into practice requires technical expertise in forecasting. An adequate number of skilled resources must be available to manage and perform the demand forecasting process. This is a particular challenge in global and national health programs, where functions are integrated and disease experts are expected to create forecasts. Demand forecasting is not an activity that can be performed simply by those with strong domain experience. While demand forecasters will need to work collaboratively with experts in the disease or product area to ensure that forecasts are valid and have real life applicability, forecasting requires separate and specialized technical skills.

Toward this end, the Working Group recommends:

Developing technical forecasting capacity within the global health community.

As mentioned above, in the past two years, several organizations have taken on the role of producing aggregate demand forecasts for particular products. However, across the wide range of global health technologies, there is still a gap in forecasting capacity and the development of credible aggregate demand forecasts that can be shared with suppliers to promote adequate and cost-effective availability of products.

In addition to the expanding forecasting expertise within PPPs, PDPs, procurement agents and others, considerable demand forecasting technical skills reside inside supplier organizations. Even in industry though, while forecasters may be skilled in methodologies for developed markets, there is limited experience in forecasting for developing country markets. The use of external consultants has helped some organizations to bridge this gap in the short term. In the mid- to long-term however, it is necessary to move beyond building the internal, proprietary capacity of consultants and focus on building technical capacity broadly for the global health community.

Recruiting students from graduate programs into global health and providing extensive training for existing personnel, perhaps through scholarships, provide two options for building core forecasting skills; another option is to recruit experienced forecasters from industry into national and global health programs.

Box 3.1 Partnerships for Training and Research in Forecasting

The Massachusetts Institute for Technology (MIT) has a special masters program focused on supply chain management that teaches forecasting skills. Its European center based in Zaragoza, Spain, is interested in providing opportunities and scholarships for global health students and practitioners. MIT has also collaborated with the Harvard School of Public Health and Tufts University to launch an interdisciplinary initiative on humanitarian studies that tailors their business and engineering curriculum to the needs of agencies involved in health and humanitarian issues.

In addition to basic skills, a new expertise in applying forecasting methodologies to the developing world, across cultures, and in resource-poor environments is required. Creating an international resource and knowledge base in forecasting methods for developing world health products could have substantial benefit to the global health community. Such a resource could be widely available to organizations involved in forecasting at the global level as well as to country-based programs. It could help to build capacity through training, commissioning research on forecasting and data collection, and providing consultation to forecasters.

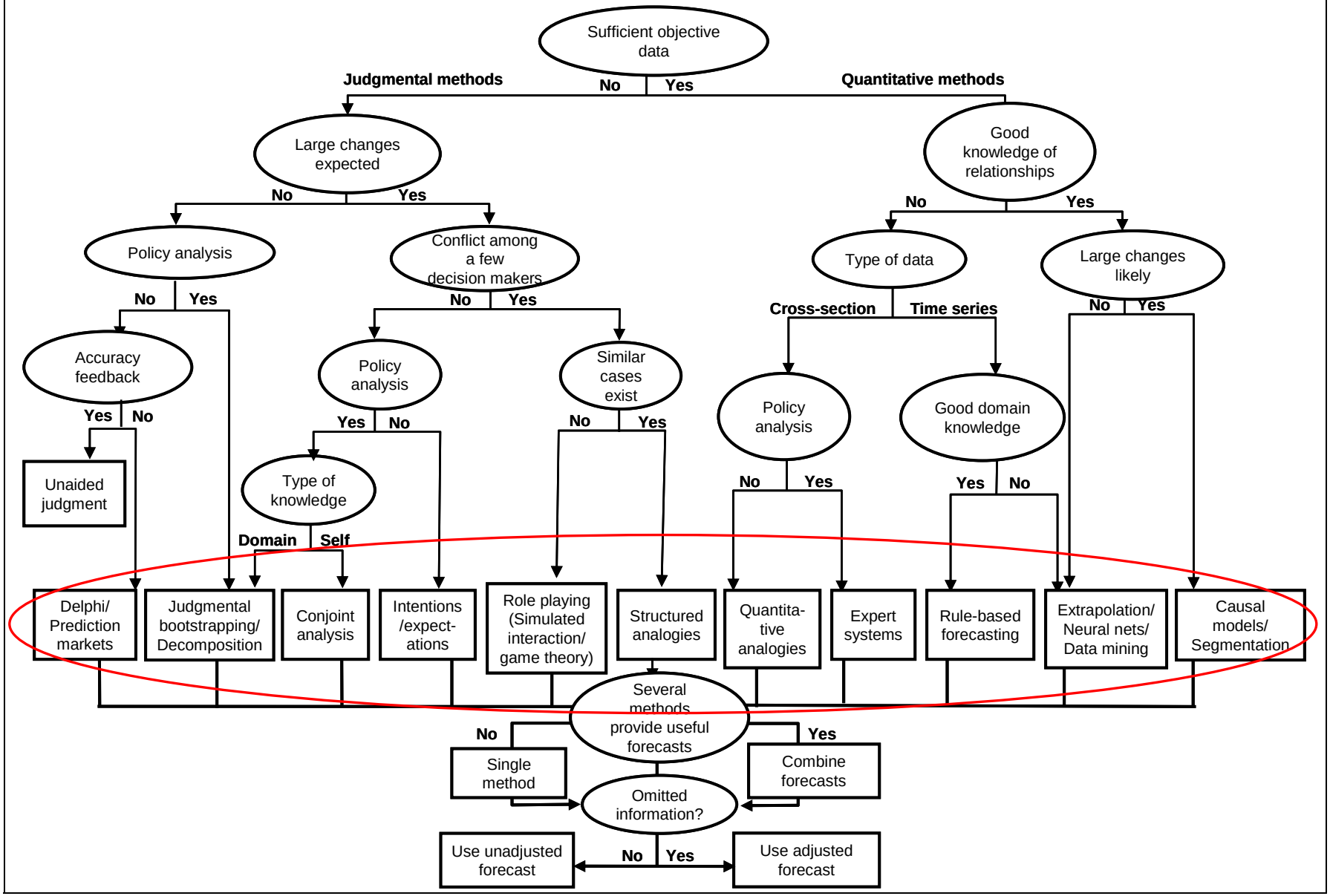
Expanding understanding and use of forecasting methods outside of health care.

Despite universal complaints about the lack of accurate quantitative data on developing country health products, the two most common methods used for forecasting demand for health products are consumption-based and morbidity-based, which are quantitative methodologies dependent on solid market research. [33] In other industries, the current conditions call for forecasting methods that encourage dialogue among a diverse set of players through systematically gathering and sharing available information, creating scenarios independent of political pressure, and combining forecasts from various sources for greatest accuracy.

In an environment with significant discontinuity, such as the one for many global health products today, forecasting methods which use qualitative input gathered in a structured fashion or a combination of quantitative and structured input are more appropriate and widely used in other industries. Figure 3.2 presents a selection tree that narrows the range of possible forecasting methods based on their suitability in various environments, with additional detail in Box 3.2. The selection tree also presents the wide range of technical forecasting methods available. For example, in the case of ARV introduction into a new market, where quantitative data are limited and large changes are expected, the tree suggests "judgmental methods" which allow qualitative input from a wide range of stakeholders to be gathered in a structured and rigorous way. This can be combined with market research, epidemiological information and other quantitative data, to provide a clearer picture of actual market demand.

The science of forecasting is constantly evolving. As technical forecasting capacity in global health grows, understanding and applying forecasting methodologies that are being used in other industries, gives greater opportunity to increase forecasting accuracy, particularly in data-poor environments.

Figure 3.2 Selection Tree for Forecasting Methods (Source: J. Scott Armstrong, *Principles of Forecasting: A Handbook for Researchers and Practitioners*)



Box 3.2 The Many Ways to Forecast

Forecasting literature suggests that the degree to which the appropriate method for a particular situation relies on qualitative input from human "judges," structured combinations of quantitative and qualitative information, or statistical techniques varies based on a product's life-stage and market conditions.[34] In general:

Methods based on judgment, or qualitative forecasts, are most useful when special events or discontinuities exist in the environment and when quantitative data are very limited. However, human judgments are subject to various errors which may be compounded when groups meet to agree on forecasts, by dynamics such as "groupthink" and the presence of dominating individuals or differences in power relationships. Several methods capture qualitative input more systematically than simple use of experts groups, including Delphi techniques, prediction markets, structured analogies, game theory, judgmental decomposition, judgmental bootstrapping, expert systems, simulated interaction, intentions and expectations surveys, and conjoint analysis.[35]

As more data become available, *qualitative and quantitative information can be integrated,* but this must be done systematically to avoid adding greater inaccuracy to forecasts. *Voluntary integration*[36] methods allow the forecaster to adjust statistical forecasts based on explicit assumptions and can improve accuracy when the forecaster has specific contextual information or can affect the forecast (e.g. change purchasing decisions)[37] and when the forecaster does not have pre-determined or political agendas for the final forecast.[38]

"Direct judgment," where individual experts modify forecasts based on their personal knowledge, is the most frequently used method of incorporating qualitative input into forecasts, but is seriously flawed due to the variety of simplifying strategies that individuals employ when assessing data, including a tendency to over-value the most recent data, underestimate the growth or decline in time-series data, see patterns in randomness, and inconsistently assign relationships between variables based on personal biases.[39] A variety of *mechanical integration* methods also exist which use statistical tools to integrate qualitative and quantitative judgments.[40]

Combining forecasts from different methods is used in many industries and can be useful when there are high levels of uncertainty or when it is unclear which methodology will produce the best results. Combining works best if forecast errors in each method are negatively correlated and will cancel each other out, but this may be difficult to achieve in practice.[41]

As comparable time-series information becomes available and the market stabilizes, *statistical methods* are preferable for forecasting.[42] These include extrapolation, quantitative analogies, rule-based forecasting, neural networks, causal models, and segmentation. Integrating human judgments for special events or circumstances into these methods will still be appropriate.

Going Further

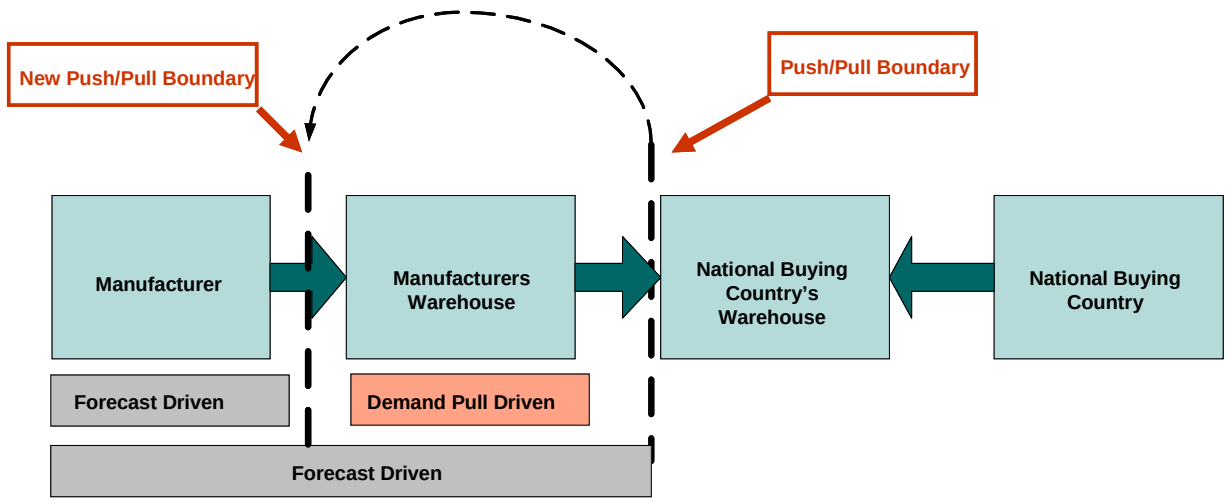
While all of the above interventions will greatly improve forecasting accuracy and credibility, forecasting can only go so far in predicting demand in dynamic and rapidly changing markets. There remains underlying uncertainty which affects short term matching of supply and demand. Many industries have confronted this uncertainty by reducing their reliance on forecasting for short term production decisions. They have essentially re-engineered their production and distribution processes to produce products on actual demand rather than on forecasts of demand. This is seen clearly in the electronics industry, where Dell Computers, for example has changed its production model to rapidly produce customized computers for its buyers immediately after an order is placed.

Health technologies present unique problems in this respect, since suppliers make critical investment decisions years in advance due to long technical and production lead times. This means price and quantity are a function of supply and *forecasted* – not actual – demand. Uncertainty about future demand therefore makes a significant difference to the probable supply response.

Once a technology reaches the market, a further difficulty arises because while suppliers are using mainly *push driven supply chains,* countries are often using *pull driven supply chains.* Push driven processes in a supply chain are based on anticipated demand, or forecasts, while pull driven processes are triggered by orders or actual demand.

Most supply chains incorporate some combination of push and pull processes. The point of interface between push and pull – the push/pull boundary (or inventory-order interface) – varies from one supply chain to another. When demand is uncertain, incorporating more pull processes into a supply chain, or moving the push/pull boundary upstream, can help to reduce supply and demand mismatches by decreasing the amount of short-term forecasting that is needed (Figure 3.3). This can be done through demand driven supply hubs, for example, which hold inventory and shorten delivery times. These are used in both in the U.S. and UK health systems, and PEPFAR is currently implementing demand-driven supply hubs for several AIDS treatment and prevention products for use in the countries they support.

Figure 3.3 Push/Pull Boundary (Source: Kirsten Curtis, MIT Zaragoza Supply Chain Logistics Center)



Conclusion

A recognition of the importance of demand forecasting and investments in technical forecasting capacity will help to ensure that patients get health products when they need them. This chapter has focused on making demand forecasting an essential part of the discussion on improving access to essential medical technologies. The next chapter deals with the importance of gathering and sharing information to improve the accuracy of forecasts.

IV. RECOMMENDATION 2: CREATE A GLOBAL HEALTH INFOMEDIARY

Taking forecasting seriously requires that we have better information about supply and demand. In fact, the first response one gets when asking, "What do we need to improve demand forecasting?" is: "Better information." Dig a bit deeper and it's clear that part of the wish for better information is in reality a desire for less underlying uncertainty (the "unknowables"): "If only we knew what donors and Ministries of Health would do in the future, we'd be all set." But a remaining part of the focus on information simply reflects the ineffective systems currently in place to measure, report and share the "knowables," including those related to disease patterns, product adoption and use, funding and other factors.

The Global Health Forecasting Working Group investigated the types of information most critical for demand forecasting from the perspectives of a wide range of stakeholders. In addition, the Working Group examined "best practices" in forecasting, looking outside of the somewhat insular world of global health to other sectors where forecasting is also crucial. From that work, we developed an understanding of the information challenges in forecasting for global health products.

Central to our discussion was the core question of the incentives that various actors in the value chain have to behave in ways that would generate, share and use information to create the best aggregate forecasts. Chapter II described the results of a risk and incentive audit for the ACT supply chain which was commissioned by the Working Group. In the area of information sharing, the audit shows that the major stakeholders – funding agencies, procurement agents, global health programs, national buyers – lack clear positive incentives to share information about demand. While they would all like to have accurate forecasts, and don't have an obvious disincentive to share this information, few are willing to invest the resources for broad information gathering and sharing because they don't bear the financial risks for poor forecasting. On the other hand, suppliers directly bear a financial risk for bad forecasting, particularly for excess capacity, but they have a disincentive to share individually identified supply information that could make them vulnerable to competitors or to anti-trust allegations.

In the developed world, the challenge of sharing supply and demand information for forecasting is solved through the use of information intermediaries, or *infomediaries*. While this role varies across industries, these are generally private firms which act as information brokers, providing a vehicle to share data among all stakeholders in the value chain and producing analyses and baseline forecasts that are useful to each stakeholder.

Also in developed countries, core market information on pharmaceutical consumption and trends is gathered across diseases in a common data repository which is operated by firms such as IMS Health, Verispan, Cegedim and NDC Health. IMS Health currently maintains the largest single data repository for basic drug information and is the most common source used by industry, governments, drug safety organizations and public health institutions. Data in these repositories are collected primarily from suppliers, wholesalers, and insurers, and to a lesser extent from governments, and can be disaggregated by disease, product, geography and time.

Some industries have gone beyond passive information sharing to recognizing that demand forecasting information is a key element of efficient supply chain coordination.[43] A variety of companies including Wal-Mart and Best Buy, along with their suppliers such as Procter & Gamble

and Kimberly-Clark, participate in the Collaborative Planning, Forecasting and Replenishment (CPFR) initiative, which was launched to "create collaborative relationships between buyers and sellers through co-managed processes and shared information." Excellent benefits have been reported from this approach.

What Information Do We Need and Who Has It?

To better understand what information is needed for forecasting for global health products, what currently exists, and the gaps, the Working Group commissioned an assessment of the data requirements of key stakeholders in the value chain. More detail on this assessment is provided in Appendix E. The findings highlight several important points:

1. Key stakeholders across a variety of disease areas and geographies require similar types of basic information for forecasting. Product-specific and disease-specific information are also necessary, but a substantial set of shared data categories serve as the foundation for demand forecasting for health products.
2. Collectively, there is more information available than one might imagine. Each stakeholder has access to several important data elements, but these are not systematically shared with others in the value chain.
3. In addition to currently available data, investment in additional data gathering through focused market research, particularly at the country level and for new products is required. Several organizations are beginning to make this investment and models are being developed, but analyses and methodologies are not widely shared.

Each of these findings is discussed below.

Common data needs and gaps exist. Several international initiatives have been recently created with the purpose of collecting and disseminating information relevant to forecasting, as their central function or as part of their broader mandate. Most of these are focused on providing information for particular diseases or products, and forecasters often go through similar processes to search for reliable data sources, and to compare and clean data so they are usable for forecasting. In many cases, researchers identify the same data sources, resulting in significant duplication of effort and resource investment to gather core information. For example, the strong link between HIV/AIDS, TB and malaria requires forecasters in any of these areas to gather information on all three to get a realistic picture of epidemiology and underlying needs.[44] Because information is not systematically shared across disease areas, resulting forecasts may not consider competing disease priorities or product developments in their projections.

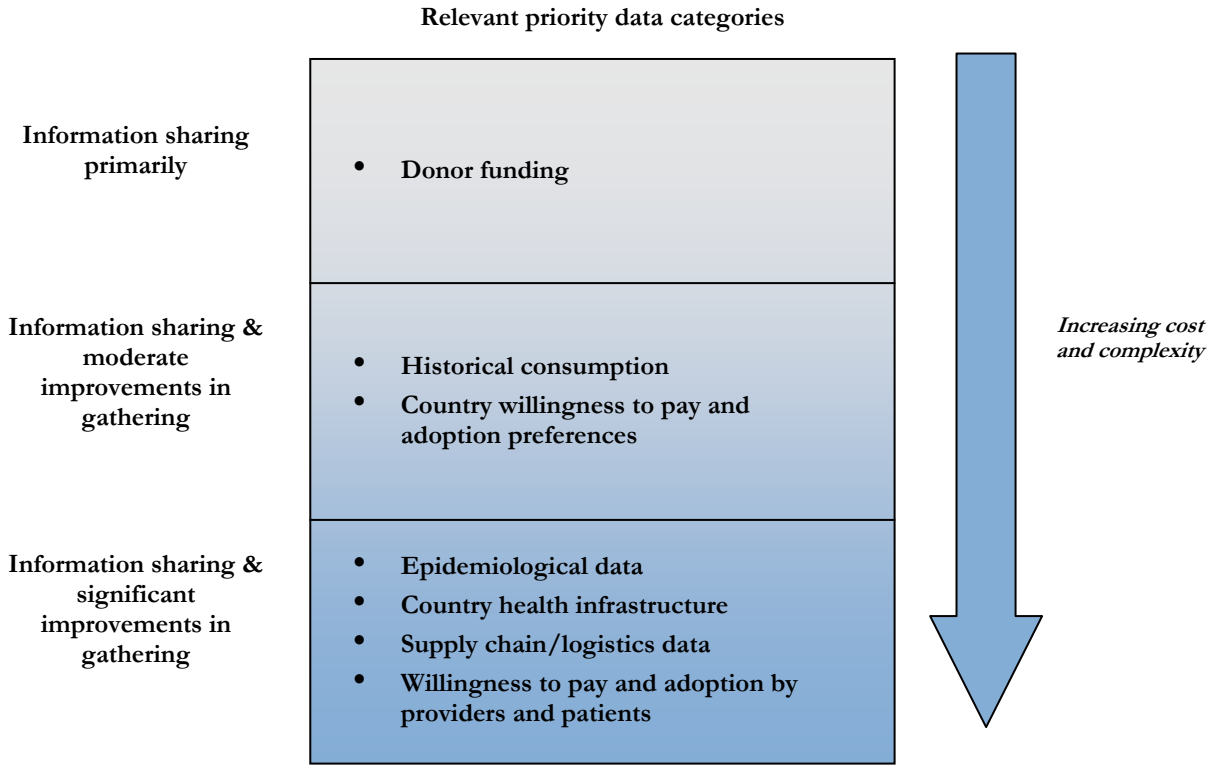
Appendix E details the most important information needs required by forecasters, grouped into five broad areas: international and macroeconomic data; population health data; product information; specific national information; and behavioral data. Of the 16 identified sub-categories of data, there are seven that present critical gaps in either data quality, availability or both across a variety of stakeholders. These are:

- Information about international donor funding and approved/projected funded demand
- Historical consumption data

- Information about willingness to pay and likelihood of adoption by policymakers at the Country level
- Epidemiological data
- Country health infrastructure information
- Country supply chain and logistics information
- Information about willingness to pay and likelihood of adoption by providers and patients

Data exist but are not shared. Data needs fall along a spectrum of information that is currently available and needs to be better aggregated and shared, to information that does not exist and will require investment in further market research (Figure 4.1).

Figure 4.1 Approaching the Information Gap



Much of the information that does exist is gathered by suppliers and a few global players including international agencies such as WHO, UNICEF, the World Bank; funders such as the Global Fund, GAVI; and large procurement agents. Though available, data are often not provided in accessible databases or in a form that is useful for forecasting without extensive research. In addition, different data sources for the same information may show widely different estimates of basic variables (e.g. epidemiology) and there does not appear to be a single source that serves as the reference for specific data elements.

While country level data are more difficult to collect and aggregate, some key data elements are gathered by international supply chain consultants such as JSI and MSH. Other data elements are housed in ministries of health, country disease programs, and with wholesalers and distributors.

The task of gathering these disparate pieces of information and ensuring consistency in data and their quality are not trivial, but it could have enormous benefit for ensuring access to life-saving or life-extending drugs and supplies.

More and better market research is needed. Filling data gaps requires investing in primary market research at a number of levels. Several types of market research are required to gather these data.

- The first level involves continuous collection of data on basic supply and demand parameters such as consumption of products by disease area and therapeutic category. This is the type of research most commonly collected by firms managing central data repositories.
- A second level of research examines policy preferences at international, national or sub-regional levels. For example, what are the factors that will determine whether Zambia will adopt a particular first line ARV regimen or a different one? How much will price play a role versus established relationships with suppliers, and potential switching costs from older therapies? What are the factors that will influence Ethiopia's adoption of WHO guidelines for the next generation of anti-malarials and how will this affect how quickly it will switch to the current version of ACTs?
- A third area of market research includes very specific, but generally *ad hoc* analyses of particular markets to provide a detailed understanding of local consumer and provider preferences. This type of research is generally done for new product introductions and is commonly performed by consumer research marketing firms or increasingly in developing countries, by social marketing firms. Primary market research at this level requires significant time and effort; for example, visiting individual vendors in Indian villages to analyze scripts for TB drugs to understand local prescribing patterns and distribution channels, and how this might affect demand for the next generation of TB therapy.

All of these types of market research provide information that can be used by a variety of stakeholders across the value chain and across diseases. For example, research on uptake rates for new products can provide market analogues for forecasting other products in similar therapeutic classes, with similar geographies, similar delivery modes and price points.

Because of the many levels of market research and the different types of expertise required to gather and analyze different types data, hundreds of firms have emerged which serve unique market research niches in rich countries. To better understand whether these firms could serve the needs of the developing world, the Working Group distributed a Request for Information (RFI) to a variety of public and private firms that specialize in information sharing, market analyses and various types of market research.

The results of the RFI and other research by the Working Group led to the following findings and conclusions:

- No single firm provides the full range of information sharing, market analysis, consulting and primary research services for a wide range of developing countries. A coordinated approach to gathering new data will require some existing or new body to develop partnerships with a wide range of firms and manage the processes of collecting, analyzing and disseminating market research studies. Most companies have concentrated on developed country markets, but many are now focusing on emerging markets particularly in Asia, Latin America, and private markets in middle income countries in Africa. Specific market research capability though, remains limited in low-income countries in Africa.
- In the area of information sharing and the first level of market research which involves continuous collection of data on basic supply and demand parameters, IMS or a similar organization with an existing large data repository of basic information from hundreds of suppliers and wholesalers provides a platform that could be expanded to gather and share data on developing world health products.
- A variety of businesses have expertise in market analysis and research across the spectrum of policy research to clinician- and patient-level data gathering. Some have worked in specific disease areas and countries in the developing world. Several have contracted with PDPs or international organizations to conduct one-off market research studies. If the market insights gained by these firms are to benefit the global health community more broadly, there needs to be a mechanism for sharing this information systematically and ensuring that data and analyses are not proprietary to the research firm. These studies should also be collected in a common repository to provide market analogues for use by other PDPs, international agencies, and suppliers.
- There is a need to build expertise in conducting primary market research in developing countries and low-income environments, and to commission studies that improve our understanding of how health products actually reach patients. This includes a range of issues such as how distribution channels function in private and public markets, what prices are paid by the patient and price elasticity at the household level, as well as which factors influence clinician prescribing patterns. If this information is to have an impact on better matching supply and demand in the health market more broadly, information, analyses and methodologies need to be non-propriety and widely disseminated. Recognizing this, some PDPs, such as the TB Alliance, have recently made deliberate efforts to share their market research studies.

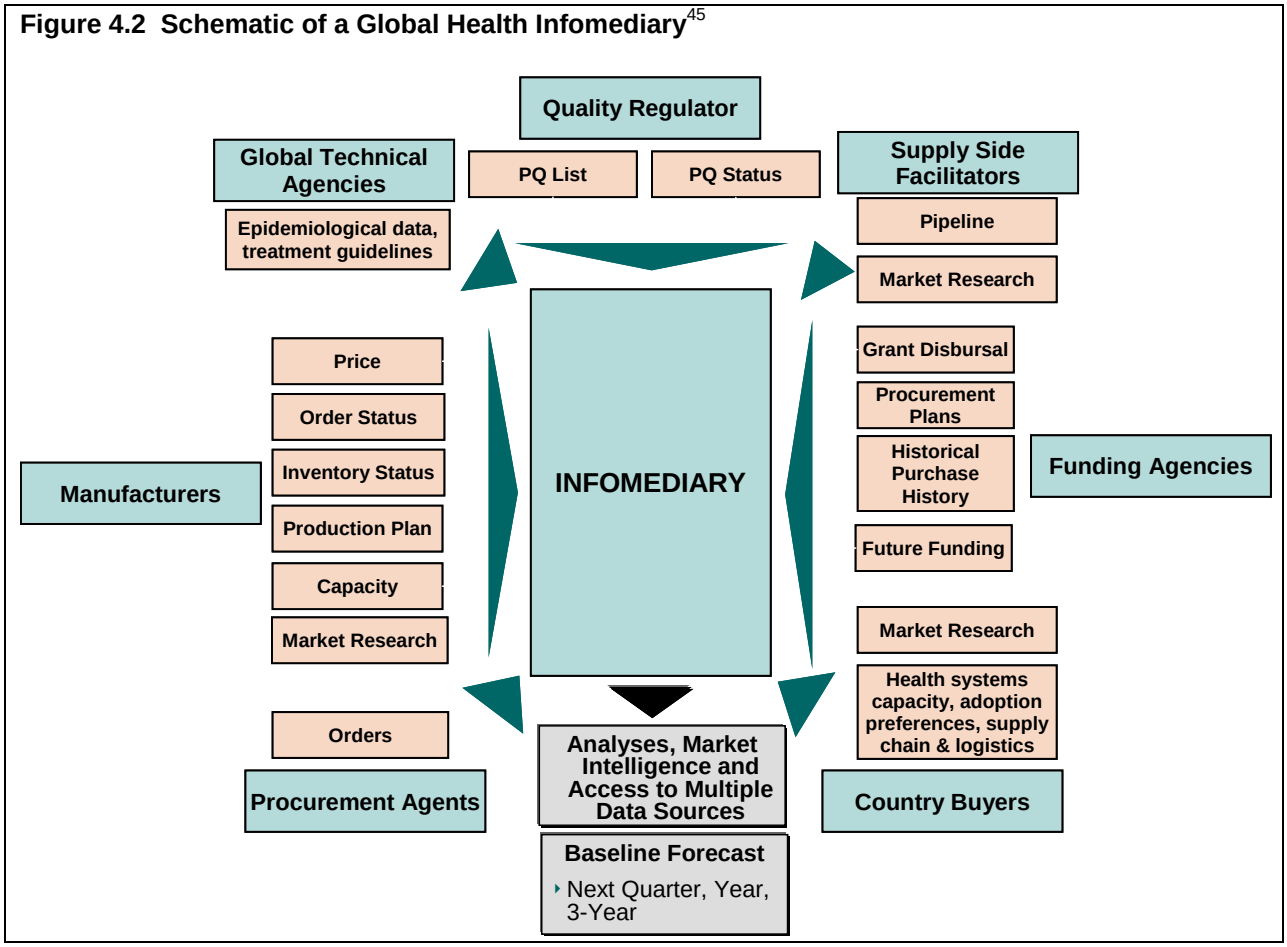
The Need for a Global Health Infomediary

Opacity of data from value chain constituents – including suppliers, funding agencies, national buyers, and procurement agents – increases demand uncertainty and its associated risks. Two aspects of information sharing help to reduce these risks. First, since each player has different information sets, combining this information will improve forecasting accuracy (e.g. the national buyer has better information about the status of procurement plans, the manufacturer knows more about supply constraints, while the procurement agent knows better about country preferences for specific manufacturers). Second, even when some information from different players overlaps, it can produce a confirmation effect that increases forecast certainty and gives greater confidence to stakeholders in the forecasts produced.

The fragmentation of the market for global health products makes accountability for information sharing diffuse and no single player has a clear incentive to share this information. This suggests the

need for an **infomediary** for global health to effectively gather and analyze data needed for demand forecasts across a variety of diseases and products and to make this information widely available to all stakeholders.

Figure 4.2 Schematic of a Global Health Infomediary[45]



The key functions of the infomediary would be to:

1. Serve as central repository of all relevant demand and supply data by collecting, synthesizing and disseminating information related to forecasting that individual organizations may not be willing or able to share independently (for example, due to anti-trust concerns).
2. Ensure data integrity and perform the labor-intensive tasks of cleaning and analyzing data received from multiple sources.
3. Establish a mechanism for ongoing, continuous gathering and updating of core forecasting information.
4. Generate transparent, baseline aggregate forecasts by product category based on the information sets provided, to serve as the common starting point for stakeholders to produce their own forecasts. Build aggregate and country level models for generating demand forecasts that consider the unique developing country environment.

5. Incorporate information from specific market research studies that are either conducted by the infomediary or other market research firms and stakeholders, to provide a more complete data repository and refine assumptions for forecasts.
6. Serve as a neutral and credible party responsible only for information collection and generating baseline forecasts, and not involved in demand generation, advocacy, target setting or other functions that could compromise the integrity and independence of activities. Maintain strong relationships with public and private supply chain partners and establish credibility with stakeholders.

Implementation Considerations for a Global Health Infomediary

Key Components

For a Global Health Infomediary to have real value for stakeholders requires three distinct but related components:

1. **Developing a repository structure** to gather and house data and provide analyses and forecasts by therapeutic category, geography and other parameters. Considerations in constructing the repository structure include:[46]

    - Database design and implementation: What data model and approach best meet the different requirements?
    - Hosting: Will the data be viewed as commercially or otherwise sensitive; will local and/or web based access be required; what response times are needed; what back up facilities are required?
    - Access: Will this be limited to specific users or organizations, or will wide access be allowed? How will individual data be protected if access is broad?
    - Reporting flexibility: Will the repository feed other external systems, what explanatory materials might need to accompany any predefined reports? How flexible can or should the in-built forecasting models be?
    - Query management: How can users access the database on an ad hoc basis to meet their individual needs?

2. **Populating the repository with available data** and creating interfaces to update these data on an ongoing basis. The task of gathering required data elements in many low-income countries will be labor intensive. Initially the repository may contain a few readily available data elements (e.g. funding data, consumption as reported by major suppliers, procurement agents and funders). Over time, this could expand to cover a wider range of information. Key considerations include:[47]

    - Data specification: What data are needed, how will the data be used and what standards will be used to ensure consistency over time and place? What expectations are there that new data types will emerge?
    - Data source management: How will data be delivered, how often, in what format? What will be the responsibility of each stakeholder to ensure data consistency and provide data in a useable format for the repository?

- Validation of source data: Who will be responsible for checking data for content, logic, completeness?
- Data input: What can be automated, what is manual, what will have to be entered locally, what can be entered centrally? How will standards be maintained? Will this be done by the source organization or will data need to be transformed?

3. **Gathering and incorporating new data** and market research studies as they are conducted. Considerations include:

- Essential market research and ad hoc studies: What gaps in data must be filled immediately and what data gaps can be filled over time as new products are launched or developed?
- Opportunities for collaborating in designing market research studies across products: Are there opportunities for commissioning joint market research; for example, would a study in India looking at the potential demand for new TB products also be able to capture information about the demand for specific HIV/AIDS therapies? Could policy research at the country level on what influences adoption of new malaria drugs also determine what influences adoption of new ARV treatments?

Selection Criteria

In selecting an organization to fill the infomediary role, it is important that it meet the following characteristics and have sufficient capacity and experience in information gathering and forecasting for health products.

- Multi-party and multi-level data aggregation and information management. The creation and management of such a large database of diverse information is not a trivial task and the selected firm must be experienced in information collection and management in health products.
- Advanced analytics capabilities. As discussed in Chapter III, forecasting demand requires a unique set of skills and is not a function that can be done by domain experts. The infomediary must have proven experience in developing forecasting models using a range of forecasting methodologies and be able to adapt these models to developing country environments.
- Most importantly, the organization should, by design, be a neutral, trusted third party that focuses only on forecasting demand, not on stimulating, advocating or filling demand. If the organization is also involved as another stakeholder in the supply chain, this can create a conflict of interest that can jeopardize the credibility of analyses and forecasts produced.

Changing Incentives

For the infomediary to be effective, the neutral or negative incentives of stakeholders to share information must be addressed by clearly defining benefits for each stakeholder. While the preceding discussion may make some of these obvious, it is worthwhile stating that for stakeholders to contribute data they must be assured that:

1. Credible outputs, analyses, and baseline forecasts are generated that help each stakeholder to better perform its core mission. For suppliers this could mean better and more complete information on demand and demand drivers so that they can appropriately scale up production

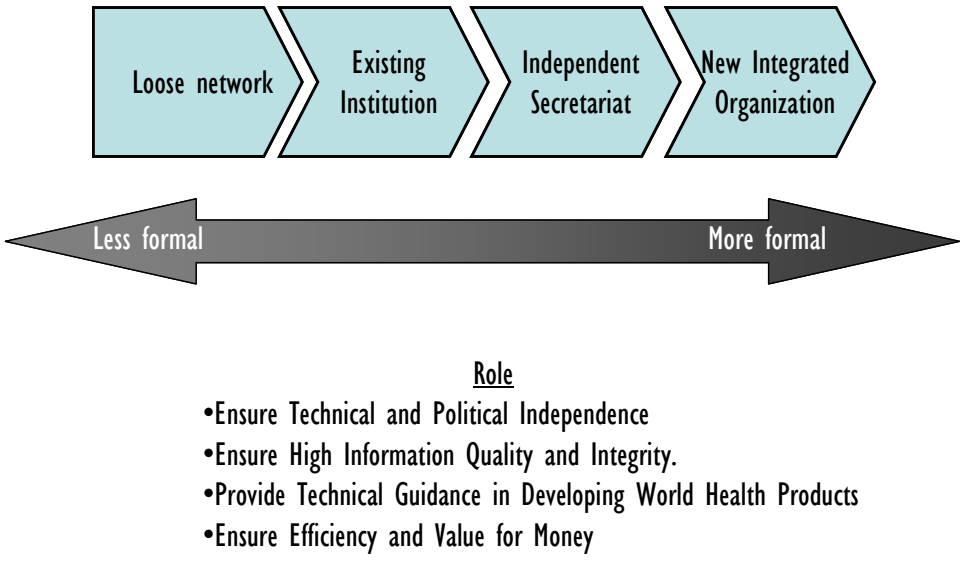
capacity, resulting in less excess inventory and fewer shortages; for PDPs, PPPs and international agencies, this may mean channeling significant time and resources that are now spent on data collection to focus on demand generation and advocacy. For funders, this could mean better matching funding flows to product needs resulting in fewer shortages and less waste of donor funds.

2. A secure sharing arrangement exists so that information collaboration can take place without revealing any participant-specific data to others.
3. Easy interfaces and other data collection and validation support are available to minimize the effort required by each player to provide their data to the infomediary and to access information relevant to them.

Institutional Arrangements and Governance Structures

To constitute the infomediary and ensure that its design and management meet the needs of stakeholders, an appropriate institutional and governance structure would need to be established. This could range from a loosely organized committee that would coordinate a network of stakeholders, to an existing organization serving as host to the infomediary, to the establishment of a separate Secretariat that would manage the interface between the infomediary and stakeholders, or finally to the creation of a new integrated entity that performs all information management, market research and stakeholder liaison functions. (Figure 4.3).

Figure 4.3 Spectrum of Governance Options for Global Health Infomediary



There are doubtless a variety of institutional arrangements along this spectrum that could be feasible and each has trade-offs that would require consideration. While the Working Group does not recommend a particular governance arrangement, it is important that whatever institutional structure is selected ensures:

- Technical and political independence in managing the relationship between the infomediary and stakeholders

- High information quality and integrity to ensure credibility in the information, analyses and forecasts produced.
- Technical expertise in developing world health products to guide data gathering, analyses, the creation of forecasting and market research models which are most relevant to stakeholders.
- Efficiency and value for money in the operations of the infomediary, data gathering, and market research.

In addition to these core functions, a variety of other forecasting related activities could be undertaken, as shown in Box 4.1 to "Take Forecasting Seriously" and improve our understanding of demand for health products in the developing world.

Box 4.1 How an Infomediary Helps Take Forecasting Seriously

1. Share knowledge on forecasting by:
- Serving as a technical resource, promoting the use of forecasting principles and sound forecasting practices.
- Providing support to organizations doing demand forecasting by responding to questions, referrals to technical forecasters, attending related conferences.
- Forming a network of those who are doing forecasting for global health products. Perhaps hosting a Forum and holding regular online and in person discussions for forecasters.
- Engaging a broader audience in forecasting activities.

2. Apply forecasting knowledge by:
- Providing support and direction in the development of market research studies, forecasts.
- Establishing framework contracts with market research firms that could be used as needed to collect data in developing country markets.

3. Develop knowledge in forecasting for developing country health products by:
- Building an expertise in forecasting for global health products thorough commissioning original, practically oriented research on relevant topics.
- Keeping apprised of the latest concepts in the field and providing tools/analyses to apply these to global health products.
- Providing assistance to organizations to test/implement demand forecasting concepts
- Taking advantage of expertise in information sharing, market research, supply chains in the developed world and adapting these tools to the developing world.

Funding and Business Model

Two distinct funding streams are required to establish the role of infomediary – one for developing and maintaining the basic repository and core data collection, and the second for commissioning studies to fill specific data gaps.

1. Start-up funding is needed to develop a repository structure to gather and house data; provide analyses and forecasts; populate the repository with available data and create interfaces to update this data on an ongoing basis; and incorporate new data and market research studies into the repository as they are conducted. This could come either through a single funder or a consortium of funders to establish the core database structure and populate it with available data.

Ongoing distribution of analyses and forecasting information to a wide range of audiences could be provided either free of charge, at a fee to clients, or at a fee to a consortia that would fund an ongoing set of information collection activities. To avoid the free-rider syndrome, different levels of access could be established that allowed more detailed information being made available to those with greater contributions in money, time, or other inputs.

2. Funding of specific market research studies to fill data gaps could continue to be done through individual institutions, or there may be opportunities to pool resources to conduct joint studies either through the infomediary or through separate firms. In any case, a mechanism to input the data gathered from these studies into the common repository would be needed to ensure that all stakeholders benefit from the research. Again, different levels of access could be established to encourage participation by all stakeholders.

Conclusion

The Working Group recommends that interested parties in the international funding, public health and supplier communities explore collaborating to create a global health infomediary. This would include the analysis of core functions and institutional options, and an assessment of costs of each of those options. A promising approach to ensure that the best possible arrangement is developed, building on the considerable expertise and institutional capacity that does exist for demand forecasting, would be to identify the core functions and issue a request for proposals that would welcome submissions from public agencies, not-for-profit private organizations, and private firms (or any combination).

Importantly, however, improvements in demand forecasting are unlikely to be fully realized without attention to the underlying asymmetries in the distribution of risk; it is only with a more efficient risk allocation that all parties who can improve information, supply chain function and funding flows will be motivated to do so. Recommendations related to risk-sharing are presented in the next chapter.

V. RECOMMENDATION 3: SHARE RISKS & ALIGN INCENTIVES FOR BETTER FORECASTING

> *Efficient contracts balance the costs of risk-bearing against the incentive gains that result. They motivate all parties to perform at or above contractually specified levels.[48] Efficient risk sharing in the market reallocates unavoidable risks in a way that makes all participants better off.[49]*

In a perfect world, demand forecasts would be accurate, transparent and shared openly across a wide range of stakeholders because this would permit more efficient functioning of the entire value chain. Unfortunately, the misalignments for forecasting discussed in Chapter II show that stakeholders need clearer incentives to produce accurate forecasts – which means that they must share more directly in the risk of producing inaccurate forecasts.

Risk sharing can be done by either changing the relationships of various stakeholders in the market, or by structuring contracts between existing stakeholders in different ways. Methods to change the basic market structure include franchising, insurance, leasing and partnerships.[50]

While opportunities may exist to change the fundamental market structure to distribute risk differently among stakeholders for global health products, there is an immediate opportunity to better align incentives and share risks through restructuring contractual arrangements. Effective contracting is also critical for ensuring that pooled purchasing mechanisms, which are being considered by many funders, achieve their objectives.

Binding contracts put teeth behind good forecasting. They make it in everyone's interest to take forecasting seriously. But binding contracts require good information, so the creation of a global health infomediary is a necessary first step for changing contracting practices.

A second step, then, is to widen the set of contracting approaches used to procure essential medical technologies. Currently, the majority of spending on products occurs in a context where manufacturers are expected to have ready supplies to respond to orders as they come in; long-term contracts with some type of risk-sharing, or minimum guarantee offtake, are rare. There are exceptions: for example, USAID and CHAI have established variations of contracts that commit to purchasing a minimum amount of a given product, while indicating the intention to purchase up to an agreed maximum. However, global health funders in general have made only limited use of the wide range of risk-sharing arrangements, which include those described below:

- **Minimum Purchase Commitments:** Minimum purchase commitments require that a buyer agrees in advance to purchase a specified quantity of product, either in a single transaction or over a period of time. By accepting some of the supplier's risk for production, the buyer has an incentive to accurately forecast demand. Typically, suppliers offer incentives to buyers to take on this risk through reduced prices for the minimum purchase commitment. Suppliers are not committed to producing above the specified amounts, so this arrangement works best for the purchaser in cases where: the long term market demand is stable; there are substitutable products that prevent the risk associated with stock-outs; or there are opportunities to off-load excess inventory.
- **Quantity Flexibility Contracts:** When there is high demand uncertainty, buyers may prefer committing to a lower level of demand while retaining the flexibility to purchase more product to guard against the consequences of stock-outs. Quantity flexibility contracts allow the buyer to

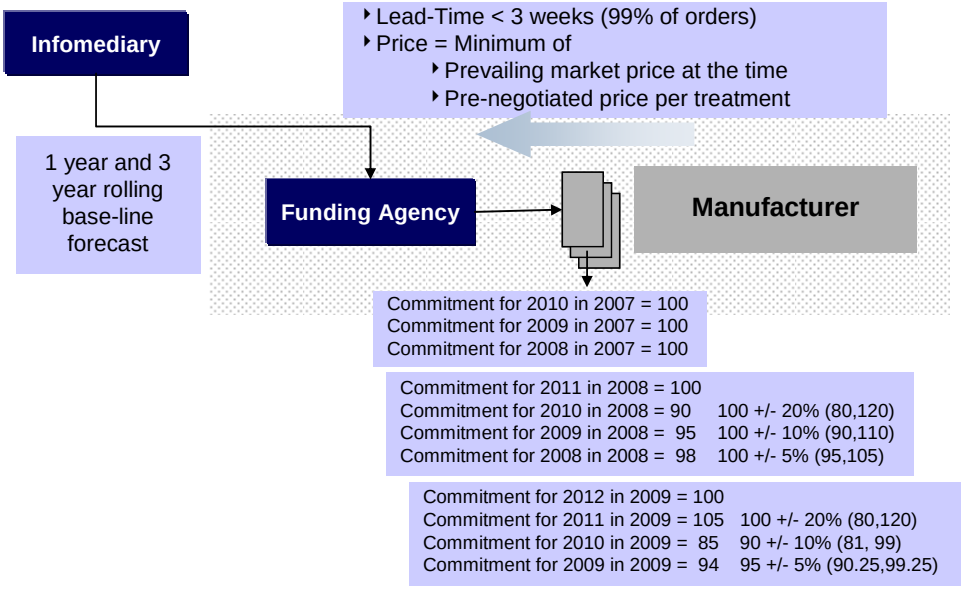
commit to a minimum amount at a certain price, while at the same time binding the supplier to make a specified quantity of product above that amount available at a premium price if additional demand arises. Suppliers may be interested in these types of contracts if the marginal cost of production is low, but the base set up costs are high; if there are multiple suppliers; or if there is uncertainty about which supplier a purchaser will select. The contract may also allow suppliers to collaborate to buy and sell excess inventory, which limits each supplier's individual risk. A variation is the rolling horizon contract described in Box 5.1 for ACTs.

Box 5.1 Rolling Horizon Forecast Commitments[51]

A *rolling horizon forecast commitment* is proposed for ACTs because it transfers some of the long-term excess inventory risk to the funding agencies, while the short-term risk is still carried mostly by the manufacturer. The mechanism provides funding agencies with a high level of long term and low level of medium term flexibility. Several examples of the use of these types of contracts exist in electronics and telecommunication equipment supply chains, and a rigorous mathematical analysis of rolling horizon forecast commitments can be found in *Quantitative Models for Supply Chain Management*.[52]

The rolling horizon forecast contract requires that the funding agency provide manufacturers with commitments to purchase a certain quantity of the product in each of the following three years with some flexibility on updating the commitment as new information becomes available. In return for the flexible purchase commitments, the manufacturers guarantee the funding agency a maximum allowed lead-time, up-side purchase flexibility and low acquisition cost. Explicit contractual penalties are defined for the manufacturer if it is not able to meet either its lead-time commitment or the up-side supply guarantee. Thus, the funding agency reduces its risk of supply shortage and price uncertainty by undertaking some of the demand uncertainty risk. This is clearly a rational allocation of risks: manufacturers control price and supply and hence undertake those risks, and funding agencies have the most influence over levers to reduce demand uncertainty and hence undertake those risks. By incorporating an appropriately chosen flexibility parameter in the purchase commitments, we can also strike a balance between the extent of risk faced by the manufacturers and the funding agencies.

Figure 5.1 Illustrative Example of Risk Sharing Arrangements in Rolling Horizon Contracts



A proposed rolling horizon forecast commitment mechanism can be illustrated with a simple example: Imagine in 2007, the funding agency provides the manufacturer with an advanced partially flexible commitment to purchase 100 units in the year 2010. In 2008, the funding agency has the flexibility of updating its earlier commitment of 100 units by +/-20%. Based on new forecast information, the funding agency can update its purchase commitment to be anywhere between 80 and 120. Let us say that the funding agency has new information to conclude that some of the orders slated to be placed in 2010 will now be placed in later years. It will revise its earlier commitment of 100 and choose a new commitment for 2010 as 90 units. In 2009, the funding agency (as it learns more precise information about quantity and timing of order placement) has the ability to further update its earlier estimate of 90 units for 2010 by +/- 10%, so the new commitment could be between 81 and 99. Assume it chooses to commit for only 85 units. At the start of Year 2010, the funding agency has one last chance to change its estimate by +/- 5% and therefore can now choose any quantity between 80 and 89, which will then become its firm commitment to purchase. The manufacturer will provide a guarantee of the availability of 89 units within a three-week lead-time. Figure 5.1 illustrates this example arrangement graphically.

The level of flexibility in the commitments at each stage and any contractual penalties for not meeting the guaranteed lead-times need to be chosen carefully based on a thorough analysis of the forecast certainty, risk aversion ability, etc. The exact timing of the placement of orders within the year is a risk that the manufacturer continues to undertake as before.

In summary, having the partial onus of long-term overage risk will incentivize the funding agencies to (1) adopt stricter policies regarding timely procurement by recipient countries and (2) allocate sufficient amounts in early stage grants to build an agile procurement organization within recipient countries.

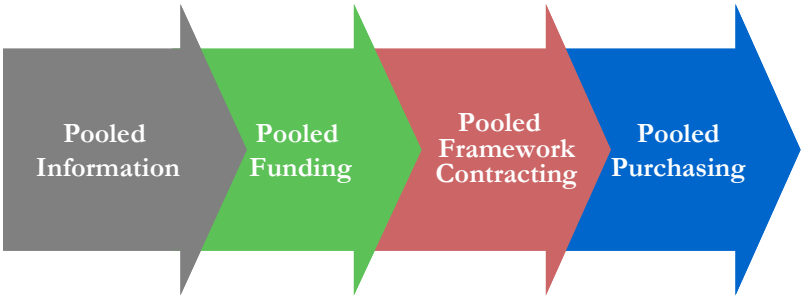
- **Buyback Contracts:** Buyback contracts are useful in situations where demand is unstable but the risk of stock out is asymmetrically distributed among the stakeholders and has significant public health consequences. They are often used when the production cycle is long and it is difficult to scale up supply rapidly in cases of higher than expected demand or where the presence of supply can stimulate demand.[53] For example, in the case of flu vaccines, it takes time to manufacture the vaccine and greater availability at the local level may stimulate demand for vaccinations, but small clinics may not be able to afford the costs of ordering more than a small amount. In this case, a supplier may encourage clinics to buy the vaccine with the assurance that the supplier will buy back some portion of the un-used vaccines at the end of the flu season.[54]
- **Revenue Sharing:** Like buyback contracts, revenue sharing is useful in situations where demand is uncertain but the presence of the product stimulates demand. This mechanism also encourages the sharing of demand and supply information between purchasers and suppliers. For example, having widespread and visible availability of bed nets can stimulate their use by customers. However, small local retailers may not have the cash flow to purchase a large number of bed nets unless they are assured they can quickly sell the nets. In this case, the supplier may make the bed nets available to local retailers at a very nominal price with the opportunity to share in the retailer's profits from bednet sales. Revenue sharing passes risk to the supplier, but also aligns supplier and retailer incentives and encourages suppliers to produce sufficient levels of supply. When this system works well, suppliers get timely information about actual sales since they share in the profits generated by those sales and can adjust production capacity accordingly.
- **Real Options:** This contracting mechanism protects buyers against price uncertainty based on the principles of financial options markets, where a buyer can purchase the right to take some action at a future time for a pre-determined price (but is not obligated to do so). Acquiring an option typically requires some costs, and its outcome results in asymmetric returns. Real options involve the actual sale and purchase of goods if and when the option is exercised. An option is

defined by the option price (upfront price paid to acquire the option), exercise price (price at which product can be purchased if the option is exercised) and an exercise date (typically a date range). A common form of real-options contracts described in supply chain management literature involves the buyer making firm commitments to the manufacturer for future year purchases (years 1, 2, 3) for a certain amount of product and purchasing an option to buy additional units at predetermined prices in years 2 and 3. Based on observed demand in the first year, the buyer decides whether or not to exercise the option in the second and third years. Real-option contracts can achieve results similar to the rolling horizon flexibility contracts that are recommended in the case of ACTs.

Box 5.2 Pooled Procurement

Many funders are using or considering what they call "pooled procurement" mechanisms as a way to reduce price and, to some extent, better align incentives in the market. The term pooled procurement has often been used as a catch-all phrase for a spectrum of activities ranging from pooling information, to pooling financing, to pooling contracting, to actually jointly purchasing drugs and commodities (which is how the term is defined in classic supply chain literature).

Figure 5.2 Levels of Pooling



The extent and manner by which pooling mechanisms move along this continuum affects how much risk is reallocated. Moving down each step along the continuum also achieves different outcomes. For example, mechanisms that pool information or funding can reduce overall risk in the market and create a more transparent environment. In some cases, this will be sufficient to address the main distortions in the market. In other cases, there will be a need to reallocate the risk remaining to ensure that the market functions efficiently. In these cases, methods such as pooled framework contracting may be needed which can be very effective for sharing risks between suppliers and buyers.

Pooled purchasing is most effective for creating new markets or reducing price. Because price reduction is a key reason for pooling purchasing, in traditional joint purchasing arrangements, buyers have very limited choice in selecting between products. While these types of arrangements can reduce price and transaction costs, they are not a particularly effective way to reallocate market risk or ensure a competitive environment for new products.

Funders and others need to carefully consider their desired outcomes to determine how far they should progress along this continuum.

Conclusion

No single contracting option is optimal across all types of products and situations. Rather a range of approaches could and should be considered which shift the current risk allocation in which funders,

procurement agents and national buyers accept little or no risk, while suppliers gear their decisions about pricing and investments in capacity to a market in which they face significant, unshared risk.

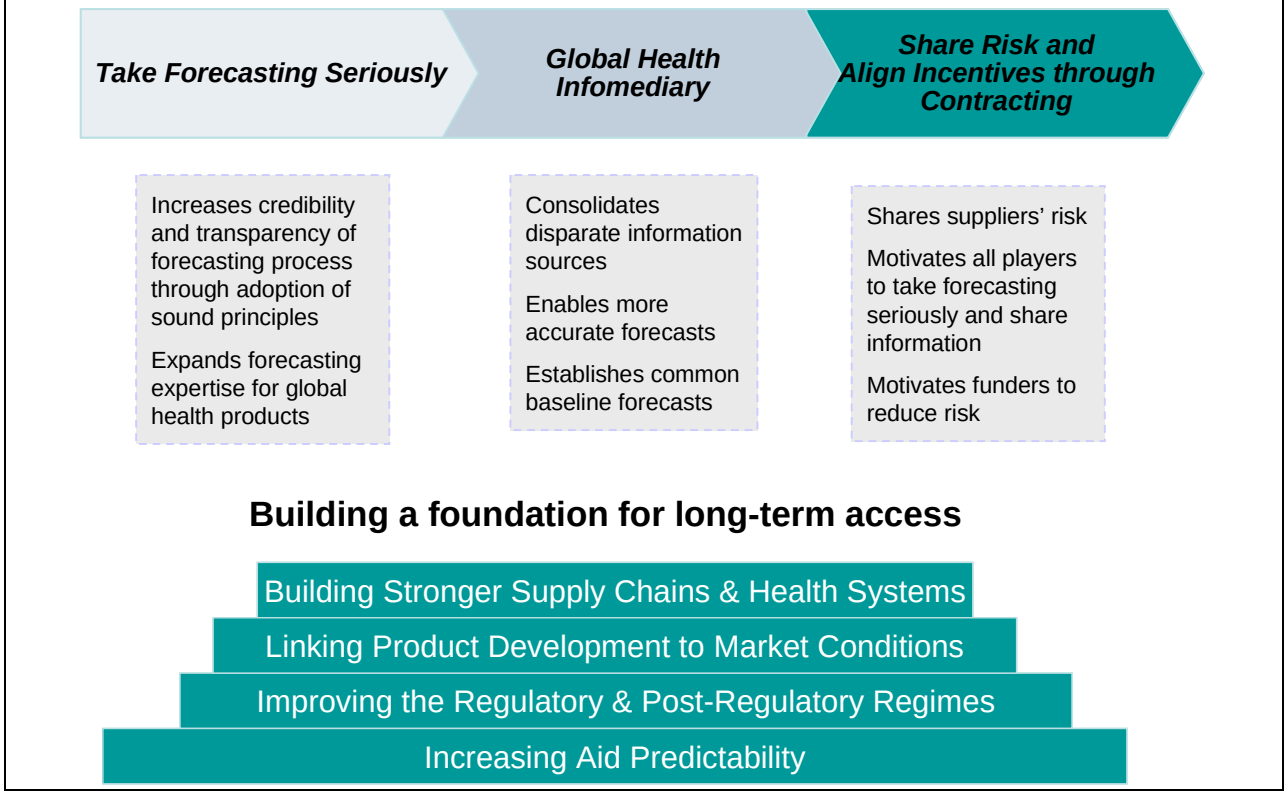
Armed with better information from a credible infomediary and key principles of forecasting, funders should be able to comfortably assume a greater portion of the risk currently borne by suppliers, which will allow for a greater return on their aid investment in the form of improved public health outcomes. Efficient contracting arrangements, in turn, will establish the incentives to improve the forecasting process itself, creating a virtuous cycle. While funders are the obvious stakeholders to bear greater risks in the supply chain, they should seek ways to have other intermediaries share in some of this risk as well. For example, as seen in the U.S. pharmaceutical supply chain, procurement agents in the role of wholesalers bear some portion of the risks for poor forecasting. Buyers also bear these risks through participating in binding contracts. There is no reason why similar risk sharing arrangements should not be considered for global health products. The benefits will accrue to everyone.

VI. AN AGENDA FOR STAKEHOLDERS

As more money is made available for the development and purchase of products that are needed to diagnose, prevent and treat leading causes of death and disability in developing countries, the need to improve demand forecasting comes into sharp relief. Inadequate demand forecasting is cited as a major deterrent to greater engagement in developing country markets by major pharmaceutical manufacturers, and the market risks associated with forecasting are the source of inefficiencies – reflected in undesirable health and financial costs.

The previous three chapters presented the major recommendations of the Global Health Working Group to address the challenge of demand forecasting in the near term: elevate demand forecasting as a vital function in the supply chain at all levels; create an infomediary to act as an impartial source of and clearinghouse for critical information about the supply of and demand for health technologies; and broaden the range of contractual arrangements for procurement of global health products to include risk-sharing between funders and suppliers.

Figure 6.1 Recommendations at a Glance



Taken together, these recommendations will dramatically improve aggregate demand forecasts for critical medical technologies at the global level. However, even with better forecasting capabilities there will remain a great deal of underlying uncertainty in these markets that requires a broader and longer-term agenda of strengthening health systems and building supply chain capacity in-country; increasing the market-orientation of product development activities; enhancing the regulatory regimes and enforcement for global health products; and improving the predictability of donor funding.

Building Stronger Supply Chains & Health Systems

The global community recognizes that the new monies for health must contribute not only to fighting particular major killers, but must also strengthen the functioning of health systems in developing countries. Considerable attention and funding is now being dedicated towards supply chain strengthening and on-the-ground logistics and technical capacity. Ideally, these efforts should also include an explicit focus on establishing information feedback systems that allow manufactures to respond more quickly to actual orders instead of relying as heavily on forecasts.

As noted in Chapter III, the current "push" systems build inventory based on a forecast of future demand; a "pull" system would replenish a preset inventory level based on observing the flow of products out to delivery sites. However, it would be far more desirable to have a pull system based on actual product orders to more quickly respond to variations in demand. As in-country supply chains are strengthened, particular attention should be devoted to shifting the "push-pull boundary" upstream.

Linking Product Development to Market Conditions

It is now possible to stimulate considerable R&D activity for global health products. The number of new vaccines, therapeutics and diagnostics may still not be sufficient to tackle the health needs in developing countries, but they represent a qualitative step in that direction. However, the successes in developing a pipeline of potential products creates its own challenges, including but not limited to: how will the product purchases be financed, through either domestic or international sources? Is the market robust enough to support several similar products simultaneously? What are the appropriate incentives to support countries' early introduction of life saving products?

Given both the positive and negative experiences to date, attention should be given within the product development PPPs to taking decisions based on a realistic assessment of market conditions, and the potential to stimulate demand, introduction and scale-up of key technologies simultaneously. The metrics of success should be related to the true health impacts of the products and the long-term capacity of the market to support manufacturers, rather than to the number of candidates in the pipeline.

Improving the Regulatory & Post-Regulatory Regimes

There is also a clear need to rigorously examine the current system of regulatory and post-regulatory processes at the global level, which has emerged as a key bottleneck in the market for critical medical technologies. In many ways, this problem exhibits characteristics similar to the demand forecasting challenge and would benefit from technical analysis involving multiple stakeholders.

Limited information about regulatory processes in low-income countries and post-regulatory processes at global levels as well as in developing countries presents a major challenge for demand forecasting. On the regulatory side, general information and expertise exists related to how to approach the internationally-recognized regulatory authorities, including the US Food and Drug Administration (FDA) and the European Association for the Evaluation of Medicinal Products (EMEA), as well as regulatory authorities in countries with large pharmaceutical industries, such as India, China, Brazil and South Africa. However, in low-income countries, little information is

available to guide the type of dossier necessary for approval of drugs and other medical products, and registration is often a very slow process.

Post-regulatory processes are even more challenging to understand and predict. Even after a product has been approved by a national regulatory agency, the process to get a it introduced into national guidelines is often unclear. At the global level, although there are technical bodies constituted to develop treatment guidelines, no formal or written procedures exist to guide how a new product obtains the status of being recommended. Without such procedures implemented at country level, a national disease control program is unlikely to change recommendations and introduce new technologies.

A set of possible solutions to these problems have been discussed, but to date only limited progress has occurred. Among the ideas debated to deal with capacity challenges is the creation of regional or sub-regional regulatory bodies whose decisions would be adhered to by multiple states; initiatives are also taking place to harmonize registration processes among participating countries and facilitate information sharing on national regulatory activities and pool resources and expertise to improve approval and review process to match the increasing complexity of product applications. Potentially, these initiatives would reduce the transaction costs for pharmaceutical companies wishing to register products, and would reduce the administrative costs for countries using a regional service. Other approaches under discussion include streamlining, increasing clarity about the required evidence, and otherwise improving the processes that WHO uses to change treatment and procedure guidelines and recommendations.

This is clearly a technically and institutionally complex set of issues, but one that would merit close attention in the near future. As for demand forecasting, a large number of the core concerns about the regulatory and post-regulatory steps in the value chain affect multiple classes of products, and so a piecemeal solution – for one set of products, or one purchaser – is likely to be less satisfactory than a comprehensive approach that serves a broad set of products.

Increasing Aid Predictability

Finally and perhaps most fundamentally for the long-term agenda, donors should increase the predictability of external funding for health, which is perhaps the most prominent source of uncertainty in the market for the highest-value global health products. Currently, predictable aid funding is the exception rather than the rule. Traditionally, the annual budget cycle in wealthy countries such as the U.S. and Japan have determined the volume and allocation of bilateral aid transfers. Funds from multilateral development banks have generally been longer term, typically over a five-year horizon. However, even for five-year projects, the year-to-year availability of resources has often been difficult to predict because of factors such as the lack of required counterpart funding, speed of procurement processes, high-level disputes between the sovereign and the bank, and so forth.

According to recent research, donor aid is 20 times as volatile as government revenue as a percent of GDP within poor countries, and 40 times as volatile as government revenue in constant U.S. dollars per capita.[55] Aid is least predictable in poor countries, and fluctuates in a particularly unfortunate, "pro-cyclical" pattern – on average it is higher when the economy is on the upswing, and falls in times of economic downturn. This is precisely the opposite of what would protect the poor against

economic shocks. The pattern is manifested because of the conditions that donors place on their funds, including maintaining IMF-prescribed macroeconomic policies that are designed to keep inflation relatively low and trade relationships open. When those policies are not in place or are not implemented – or when donors and private investors lose confidence in the face of allegations of corruption – countries simultaneously confront economic downturn and less external aid.

Moreover, aid promised does not always mean aid delivered. On average, less than 60% of the aid committed actually makes it to programs. That does not even take into account the share of aid that fails to reach developing countries because of the expense associated with government contractors and other intermediaries.

Discouragingly, donors' track record of living up to commitments seems to have worsened in the past five to 10 years.[56] This unpredictability greatly limits the ability of developing country governments to plan sensibly. Thus, those who count on development assistance do not know whether next year's (or next month's) deliveries of essential drugs will arrive, or whether the funding will be in place to build schools, health centers and rural roads – or even to finish the investments already started. Moreover, it means that governments find it difficult to efficiently procure drugs, vaccines and other commodities because they cannot commit to long-term contracts.

Newer aid instruments in health do show significant promise, and are partially inspired by recognition of the need for greater predictability. The GAVI Fund, for example, provided five-year grants for vaccine and supplies purchase during its first phase, 2001-2006, and in the second phase will provide commitments for periods up to 10 years. UNITAID, funded largely through airline levies, is intended to provide a steady flow of resources for the procurement of second-line antiretrovirals, pediatric AIDS formulations, and new anti-malarials, albeit against an expanding set of needs for them. These efforts for more predictable development assistance are important, and deserve the highest level of attention.

This long-term agenda is an ambitious one, but major steps have been taken or are being taken in each area. The Global Health Forecasting Working Group lends strong support to this work, and emphasizes that progress in health systems, regulation, product development and health finance is essential to avoiding and reducing unnecessary risks. These efforts will work to reinforce the important gains that can be made in the nearer term to improve forecasting and share risk toward the goal of broad access to critical medical technologies.

The recommendations developed by the Working Group are feasible in the near term, with relatively modest financial resources. They are, in sequential order: improving the capacity to develop credible forecasts; mobilizing and sharing information in a coordinated way; and sharing risks through contractual arrangements that are relatively new to global health but have been used successfully in other fields. Implementing these recommendations would result in a major enhancement in the relationship among funders, suppliers, intermediaries and users of health products, and go a significant distance toward achieving the sort of alignment across participants in the global health value chain that is essential for long-term improvements in access to quality products. Far from being small technical "band-aids," these recommendations would contribute to making the new monies and new products realize their potential in better health outcomes in the developing world.

GLOSSARY

Aggregate Demand Forecast: Estimate of the total effective demand for a given product during a specific time period, given assumptions about price (measured in product quantity)

Demand Forecasting: Ongoing management process of planning and determining which products will be purchased, where, when, and in what quantities (given assumptions about price)

Effective Demand: The portion of the affected population expected to have access to the product given country policies and infrastructure, adjusted for individual and country willingness and ability to pay (represented by a curve as a function of product price)

Infomediary: A neutral third-party provider that acts as a custodian, agent and broker of customer information and serves as an intermediary between those who want the information and those who supply the information.

Long-term strategic demand forecast: Long-term hypothetical forecasts of effective demand (aggregate demand) for early-stage products in the development pipeline, assuming various product specification;' used to make an R&D investment case to suppliers and/or funders (sample product: AIDS vaccine)

Mid-term demand forecasts: Demand forecast for a new product entering the market within a 5-year time horizon, when the supplier has been identified and general product specifications are known, or a multi-year sales forecast for an existing product; primarily used to guide manufacturer's capital investment decisions or a buyer's future funding needs (sample product: pneumococcal vaccine)

Need: Number of people affected by a disease based on epidemiological data and the proportion of those requiring treatment

Price elasticity of demand: A measure of the degree to which the quantity demanded changes in response to an increase in a product's price

Pull Systems: Supply chains where flows are driven by actual demand (e.g. orders or consumption)

Push Systems: Supply chains where the flow of goods is driven by forecasts of demand

Supply Chain: A coordinated system of organizations, people, activities, information and resources involved in moving a product or service in physical or virtual manner from supplier to customer. The entities of a supply chain typically consist of manufacturers, service providers, distributors, sales channels (e.g. retail, ecommerce) and consumers (end customers). Supply chain activities transform raw materials and components into a finished product that is delivered to the end customer.

Supply Chain Demand Forecasts: Used for routine, short-term forecasts of existing commodities to guide short-term production decisions and management of the supply chain after product has entered the market; also known as sales forecasts (sample product: DTP3 vaccine)

Value Chain: Encompasses the supply chain as well as the research and development process

Appendix A. Working Group Member Biographies

The Global Health Forecasting Working Group was comprised of the following members, who served in their individual capacity and not as representatives of their institutions.

Deborah Atherly is a Health Economist and Policy Officer for PATH's Immunization Solutions Strategic Program, primarily for the Rotavirus Vaccine Program. Rotavirus is a potential new vaccine for developing countries and for GAVI funding, and Atherly is responsible for developing economic information on drugs, vaccines, and devices, as well as studying the cost-effectiveness of the rotavirus vaccine and creating financing strategies. She also manages a study on the economic impact of Hib vaccine introduction in Senegal. Atherly holds an MPH from the University of Washington's School of Public Health and is a PhD candidate in the University of Washington's Pharmaceutical Outcomes Research and Policy Program.

Jorge Carrion, Pan American Health Organization

Rob Chisholm has worked in the pharmaceutical industry for 12 years, focusing on in all aspects of forecasting and market research for early stage development projects to large blockbuster products. He has worked for Western and Asian pharmaceutical companies, working on both emerging and developed pharmaceutical markets. Most recently he was Head of Global Market Research for Ranbaxy.

Renia Coghlan is the Associate Director for Global Access at the Medicines for Malaria Venture. She has 15 years of international health policy experience, with the public and private sectors, NGOs and WHO, and brings experience in access, delivery, market launch and policy for medicines and medical technologies. She holds degrees in International Politics, Business Administration and Public Health.

Peter Evans is an expert in the area of procurement. Most recently he has provided the strategic procurement advice in the establishment of the Asthma Drug Facility and the Global TB Drug Facility. During the 25 years professional service within the United Nations system, he has been Chief of Procurement of WHO, Chief of Vaccine Supply and Quality WHO, Chief of Medical Procurement for UNICEF and Chief of Procurement for UNFPA. Evans holds a Bachelors degree in Chemistry and started his professional life in pharmaceutical and vaccine production. He later studied Purchasing at the University of Toronto, becoming a Professional Purchaser. He co-authored *Managing Vaccine Supply,* the companion reference to *Managing Drug Supply,* and as a sideline holds patents on several types of auto-destruct syringes.

Gian Gandhi is a Manager of Policy Research & Analysis at the International AIDS Vaccine Initiative. He currently leads a research team focusing on demand forecasting and cost-effectiveness analyses for AIDS vaccines; his other research also includes investigation and development of R&D incentive mechanisms to stimulate further engagement of the private sector, in the search for an AIDS vaccine. Prior to his working at IAVI, Gandhi spent six years working in the pharmaceutical industry in a variety of managerial and research positions in health economics, epidemiology, health policy and market access teams covering these issues for HIV, vaccines, oncology, neurology and respiratory disease portfolios. He holds Master's of Science. in Health Economics from the University of York.

John Hurvitz is a partner at the law firm of Covington & Burling, where he is Co-Chair of the Firm's Life Sciences Industry Group and Chair of the Firm's Technology Transaction Group. He has extensive experience structuring and negotiating commercial, corporate and partnering transactions in the life sciences industry, including highly-complex alliances to develop and commercialize products, mergers and acquisitions as well as product and business acquisitions and divestitures. In addition, he is an Adjunct Professor at Georgetown University Law Center, where he teaches a course on the regulation of drugs, biologics and medical devices. Hurvitz has been active in global health matters. He worked closely with Center for Global Development in developing the architecture for its Advance Market Commitment proposal, as reflected in *Making Markets for Vaccines: Ideas to Action* (CGD, 2005), and subsequently worked with the World Bank and the GAVI Alliance in connection with the recent funding of a $1.5 billion AMC for a pneumococcal vaccine. He has also represented the International AIDS Vaccine Initiative, the Global HIV Vaccine Enterprise and GAVI on a range of issues. Hurvitz holds a BA from Haverford College and a JD from Yale Law School.

Stephen Jarrett is the Deputy Director of UNICEF Supply Division, where he is responsible for strategic supply issues and problem solving and oversees the global procurement and management of vaccines, pharmaceuticals and immunization materials acquired by UNICEF for over 100 developing countries in all regions, valued at over $1 billion annually. He maintains contact with senior management in pharmaceutical and vaccine companies worldwide and oversees the procurement services offered by UNICEF to partner agencies in international development. Jarrett has recently completed 35 years of service with UNICEF in various capacities, including field assignments in several countries in the Americas in the 1970s and as senior health officer in China in the 1980s, supporting the achievement of universal child immunization. Prior to his current position, he was working in UNICEF as a senior adviser on health systems strengthening, with a focus on drug supply systems in sub-Saharan Africa and other low-income countries. Jarrett holds a Bachelor of Sciences degree in Civil Engineering from the University of Southampton, U.K. and a Masters in Public Health degree from Columbia University, New York, U.S.A. He has published numerous articles on issues concerned with immunization and health services strengthening.

Andrew Jones works on health policy issues at the GAVI Alliance, focused on new vaccine introduction. He has been at GAVI since 2003 where he initially worked on innovative financing instruments and was involved in GAVI's work to develop and launch the International Finance Facility for Immunization (IFFIm). He has worked on Advanced Market Commitments with the World Bank, taking the initial work of CGD and others into a workable pilot for pneumo. In addition, he coordinated the work of GAVI's supply strategy group and is the focal point for vaccine supply and procurement activities at the GAVI Secretariat. Previous to his work at GAVI, Jones worked for the Canadian International Development Agency where he worked on health systems and immunization issues as a health policy advisor. Jones also worked as an adviser to one of the senior government whips in the House of Commons in the United Kingdom. Jones' original background is in science research where he did graduate work on human genetics. Following that, he completed a joint master's degree with the London School of Economics and the London School of Hygiene and Tropical Medicine in Health Policy Planning and Financing.

Steve Kinzett is a public health specialist currently working as the technical advisor to the Reproductive Health Supplies Coalition based in Brussels, Belgium. With experience in over 25 countries in Africa, Asia and Latin America he has conducted forecasting and procurement planning

for a whole range of public health commodities including contraceptives, condoms, STI drugs, HIV tests, ARVs and safe motherhood commodities on behalf of UNFPA, USAID, DFID and for Country governments. Previously a lecturer in demography and population studies at the University of Wales in Cardiff (till 1997), a senior technical advisor with the JSI/DELIVER project (1997 to 2001) and the Country Director in Kenya for the DELIVER project (2001 to 2006) he has contributed to many technical publications particularly assessing Contraceptive and Logistics Management Needs for UNFPA in several countries. He has also written several articles including one presented at the Durban HIV/AIDS conference entitled "*Controlling HIV/AIDS Transmission: estimating realistic condom requirements*" (JSI, 2000).

Ruth Levine (Chair, Global Health Forecasting Working Group) is a health economist with 15 years of experience working on health and family planning financing issues in Eastern Africa, Latin America, the Middle East, and South Asia; she currently manages the Global Health Policy Research Network at the Center for Global Development. Before joining the Center, Levine designed, supervised, and evaluated health sector loans at the World Bank and the Inter-American Development Bank. She also conducted research on the health sector, and led the World Bank's knowledge management activities in health economics and finance between 1999 and 2002. From 1997 and 1999, she served as the advisor on the social sectors in the Office of the Executive Vice President of the Inter-American Development Bank. Levine holds a doctoral degree from Johns Hopkins University, has published on health and family planning finance topics, and is the co-author of the books, *The Health of Women in Latin America and the Caribbean* (World Bank, 2001), *Millions Saved: Proven Successes in Global Health* (CGD, 2004), which has been on the required reading list at more than 33 schools and universities in the US and abroad; *Making Markets for Vaccines: Ideas to Action* (CGD, 2005); and *When Will We Ever Learn? Improving Lives Through Impact Evaluation* (CGD, 2006).

Andrea Longhi, UK National Health Service

Elisabetta Molari, Global Fund to Fight AIDS, Tuberculosis & Malaria

Morgan Musongole is a pharmacist with 28 years of experience working on health in the pharmaceutical sector in the United Kingdom. He is currently working in the Zambian Ministry of Health as the drug logistics specialist to manage supply chain management of newly introduced ACTs including: ensuring efficient delivery of antimalarial drugs to the points of consumption; developing and adopting a routine efficient system for drug availability; developing an accurate quantification for national health facility and district requirements for antimalarials; and forecasting and procuring antimalarials to satisfy national requirements. Before joining the Ministry of Health, Musongole has worked in several pharmaceutical companies in the UK and Zambia in various capacities, and he was the first Zambian to have formulated and produced artemether/lumifantrine tablets and ARV triple combination of Nevirapine, Stavudine and Lamivudine in Zambia (all of which are registered by the pharmaceutical regulatory authority in Zambia and also in Mozambique). Musongole holds a BSc degree in Pharmacy from Robert Gordons University in Scotland, with a Diploma in Pharmacy Technology and a Certificate in Business Administration, Logistics Management and ACT Procurement.

Angeline Nanni is the Director of Vaccine Supply and Finance PneumoADIP. Before joining PneumoADIP, Nanni worked for Baxter Healthcare Corporation as a Senior Manager in the

Vaccines Commercial Division, where she was responsible for the strategic planning and market research for new pipeline products. Prior to working in industry, Nanni worked at Johns Hopkins Bloomberg School of Public Health in Departments of Epidemiology and Mental Health for 7 years.

Donné Newbury, Bristol-Myers Squibb

Hans Rietveld is Director of Global Access and Marketing for the Malaria Initiative at Novartis. In this capacity, he was instrumental in redirecting the Coartem brand strategy creating the basis for today's successful roll-out at unprecedented large scale in the public sector. He held various positions in marketing and sales both within country operations and at company headquarters. Since 2004 he serves on the Board of the Roll Back Malaria partnership as an alternate board member representing the private sector constituency. Prior to working in the pharmaceutical industry, he was a management trainee with PFW Aroma Chemicals, then a subsidiary of Hercules Inc. He holds a Bachelor's degree in Economics and Marketing.

Mark Rilling, U.S. Agency for International Development

Nina Schwalbe is the Policy Director at the Global Alliance for TB Drug Development, where she is responsible for engaging stakeholders from high burden countries in clinical trials and drug development, increasing awareness among policy makers about the need for new drugs, and creating an evidence base around policy related questions. Prior to joining the Alliance in 2005, Schwalbe spent seven years at the Open Society Institute, where she established and directed the public health program for the Foundation's global network. In that position, Schwalbe managed a public health program spanning 40 countries and encompassing a range of critical issues, such as workforce development, quality assurance, health policy and initiatives for vulnerable populations. In addition, she was directly responsible for the foundation's TB and HIV efforts and established the first harm reduction programs for HIV prevention in Russia. She has also managed reproductive health programs at AVSC International (now EngenderHealth) and the Population Council in New York, the former Soviet Union and Southeast Asia. Schwalbe holds a Masters of Public Health from Columbia University, a certificate from the Harriman Institute in Soviet Studies, and a Bachelor of Arts in Russian and Soviet Studies from Harvard University.

Neelam Sekhri is the Chief Executive Officer of the Healthcare Redesign Group Inc., bringing over 25 years of experience in health financing, health systems and health services management. She has worked with, purchasers and payers, managed the delivery of integrated healthcare services, and advised government ministries, insurers, providers and international organizations. Sekhri served as health financing and policy advisor at the World Health Organization until January 2007, where she was responsible for providing technical and policy guidance on health financing strategies with a particular focus on private and social insurance, and methods to complement public financing with private funding instruments. Prior to founding the Healthcare Redesign Group Inc., Sekhri spent 14 years with Kaiser Permanente where she held executive positions in hospital and medical group management, organizational development, and finance. She currently serves on various boards, including the Commercial Advisory Board of the British National Health Service and the OECD Working Group for Private Insurance. Her recent publications include, *Private Insurance, Implications for Developing Countries*; *Regulating Private Insurance to Serve the Public Interest*; *Getting More for their Money: A comparison of the NHS and Kaiser Permanente; Cross-Border Health Insurance: An Overview of Mexico and the United States*; *Managed Care: the U.S. experience*; and *Global Health Care Markets*.

Marcus Soalheiro Cruz, Nortec Quimica

Anil Soni is Executive Vice President for Access Programs at the Clinton Foundation HIV/AIDS Initiative, where he leads global activities to negotiate pricing agreements with suppliers of HIV/AIDS medicines and diagnostics and to assist more than 60 countries access associated products and prices. From 2004 to 2005, Soni was the Executive Director of Friends of the Global Fight, a nonprofit that advocates in the United State for increased public leadership and private engagement to support the Global Fund to Fight AIDS, Tuberculosis and Malaria. Previously, Soni served as the Advisor to the Executive Director of the Global Fund in Geneva, where he provided senior policy counsel to guide the organization's development and operations in its first two years. Soni was also a consultant at McKinsey and Company, where he served such clients as the Bill & Melinda Gates Foundation and the Botswana Ministry of Health. He also worked for the Northwestern Memorial Hospital, in the White House Office of National AIDS Policy, and with nongovernmental organizations in Ghana and the Middle East. Soni graduated magna cum laude from Harvard College in 1998.

Jeffrey Sturchio is Vice President for External Affairs, Human Health – Europe, Middle East and Africa at Merck & Co., Inc., in Whitehouse Station, New Jersey. He is responsible for the development, coordination, and implementation of a range of health policy and communications initiatives for the region. Sturchio holds an A.B. in history from Princeton University and a Ph.D. in the history & sociology of science from the University of Pennsylvania. He has been a Postdoctoral Fellow and Senior Fellow at the Smithsonian Institution's National Museum of American History.

Krista Thompson is the Vice President & General Manager for Global Health at BD, a medical technology company providing devices, such as auto-disable syringes, and diagnostics relevant to HIV/AIDS, TB, and malaria in the developing world. She is responsible for both increasing access to the company's current technologies, as well as coordinating investments in new technologies appropriate for these environments. Thompson has a BS in Medical Technology from Indiana University and an MBA from New York University.

Christine Tonkin is the Director of the UN Inter-Agency Procurement Services Office. She worked extensively in the area of government procurement for several years prior to joining IAPSO, most recently as the Director of Queensland Purchasing. Tonkin's expertise is in procurement management and associated organizational development and change, with particular interests in procurement-related cost reduction, effective use of electronic commerce, formation of effective supplier relationships and in the development and retention of procurement and contract management skills. She has an MBA with a concentration in accounting from Queensland University of Technology and a Graduate Diploma of Procurement Management also from Griffith University.

Saul Walker is the Executive Director for Global Public Policy at the International Partnership for Microbicides, where he is responsible for leading IPM's contribution to the international policy agenda on microbicides and the development and introduction of new health technologies to meet the needs of developing countries. Before joining IPM, Walker managed the implementation of the U.K. Policy and Plans on Access to Medicines in developing countries at the U.K.'s Department for International Development. This included coordinating policy responses across government departments on such issues as public health, partnership with the pharmaceutical industry and strategies to support research and development of health commodities for developing countries.

From 2001 to 2004, Walker was Policy Advisor for the International AIDS Vaccine Initiative and focused on strategies to ensure rapid access to and widespread and appropriate use of future HIV vaccines, and led policy engagement with the European Commission and European Parliament. From 1997 to 2001, he was Senior Policy Advisor to the National AIDS Trust (U.K.) where he focused on international HIV policy, the participation of people living with HIV in policy development and the needs of African communities affected by HIV living in the U.K. He is currently a Trustee Director of NAM Publications, a community-based HIV information provider based in the U.K. Walker has a B.A. (Hons.) in Social and Political Science from King's College Cambridge and an M.A. with Distinction in Philosophy and Social Theory from the University of Warwick

Edward Wilson is a public health logistics and information technology specialist with 25 years of experience working in Africa and Asia. He is currently IQC Manager for the $2.75 billion USAID-funded USAID|DELIVER PROJECT, a contract implemented by John Snow Inc. (JSI) whose objective is to increase the availability of essential health supplies in countries supported by USAID. Prior to that Wilson served as Director of the DELIVER Project (the precursor to the USAID|DELIVER PROJECT), as team leader for JSI's Software Development Group, and as Deputy Chief of Party for JSI's Child Survival/Family Planning Services Project in Nepal. Wilson has worked in 16 countries in Africa, Asia, and the Near East and holds a master's degree in management information systems from George Washington University.

Project Staff

Jessica Pickett is a Program Coordinator for the Global Health Policy Research Network at the Center for Global Development, where she manages the Global Health Forecasting Working Group, oversees outreach and communications related to the Advance Market Commitment and Global Health Indicators Working Groups, and edits the Global Health Policy blog. Prior to joining CGD, Jessica supported fundraising and communications activities at the GAVI Fund. She holds a degree in Public Policy from Duke University with a concentration in health.

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Appendix B. Uncertainty & Risk: Using Economic Concepts to Identify the Role of Forecasting

The pharmaceutical enterprise is generally considered to be a "risky" one, with the main sources of risk associated with distinct steps in the supply chain. From the suppliers' perspective, risk is seen as part of the stages of R&D, manufacture, and selling products, including but not limited to:

- The transition from investments in the basic scientific discovery process to viable molecules that merit clinical studies.
- The "survival" of products being tested through the phases of clinical studies, so that they are candidates for licensure, through a regulatory pathway that may have unpredictable elements.
- The inclusion of a product on a list of recommended products and/or on a particular financier's or institution's formulary.
- The ability of manufacturers to secure adequate supplies of raw ingredients and/or to create biological products in a predictable fashion, at a marginal cost that permits the manufacturer to clear an expected level of returns, given a particular product price.
- The effective demand expressed by consumers or their agents, given a particular price, which manufacturers must predict with sufficient lead time to meet the demand.
- Post-marketing issues of adverse events, which may cause public relations and/or liability problems.
- The emergence of competing products, either those that directly compete (e.g., in same class) or those that reduce the incidence of the health condition for which the product is indicated. Among other effects, the presence of competing products may lead to the exclusion of products from recommended lists and/or formularies.

From the perspective of consumers and financiers, available supply and/or price may be unpredictable.

While those in the pharmaceutical business face these risks to some degree in all product lines and markets, there are many ways in which products for developing country markets are seen as particularly risky. A few of the key reasons are listed below:

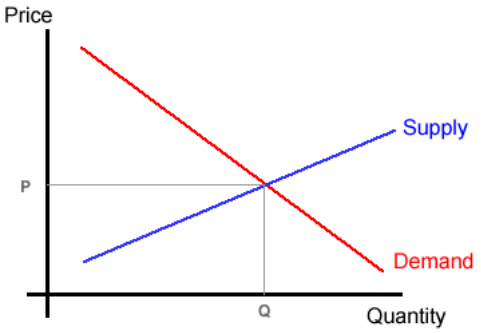
- *R&D stage:* Firms may know less about how to manage clinical trials in developing countries, and may face greater logistical, political and other obstacles, and because of historically low levels of investment in products for developing countries, much of the basic science may be in a less advanced stage.
- *Licensure and regulatory stage:* Manufacturers may be required to comply with national regulatory processes with which they are unfamiliar, and may not know either the criteria for or timing of the WHO recommendation and pre-qualification processes.
- *Manufacturing stage:* Basic historical consumption data that is routinely available in industrialized markets may be scarce and donor financing and price sensitivity may not be predictable. There can be political / public relations pressures for manufacturers to offer products at low margins, and competing products may emerge rapidly, particularly if and when intellectual property regimes are challenged.

Although all of the issues described above are often referred to as risks, some are what economists would refer to as "risks," because the decision makers know the probabilities of distinct outcomes, and others are more precisely referred to as "uncertainties," because they represent situations in which this randomness cannot be expressed in terms of mathematical probabilities. In real life – and certainly in the pharmaceutical sector – a spectrum of unknown situations are represented, ranging from those in which we know the likelihood of all the possible outcomes at one end (i.e., risk) to those in which we have no knowledge of the likelihood of possible outcomes at the other (i.e., uncertainty). The difference between risk and uncertainty is often *subjective*: it relates to the information that is available to an individual.

Taken together, the set of risks and uncertainties in the pharmaceutical sector gives the appearance of a wildly unpredictable situation, in which it is impossible for manufacturers to know how much to produce for what price to maintain a viable business, and equally impossible for consumers (or those who finance their pharmaceutical purchases) to know how much dealing with particular health problems will cost. However, when the "risks" are disentangled a bit, regularities emerge – and the dynamics of the market help, over the long-run, to establish demand-supply equilibria. Moreover, specific actions can be taken to smooth out the unpredictable features that are manifested in the short-run, partially protecting both suppliers and consumers (and funders) from shortfalls in revenue and/or products.

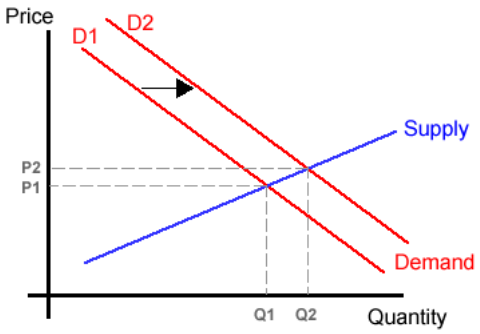
In the pharmaceutical sector, as in all other business domains, decisions are taken with the full knowledge that outcomes are unknown; sometimes the bets will pay off with positive returns, and sometimes they will result in losses. When decisions are made in risky situations, the "expected returns" from each choice serve as a guide to action. The expected return is calculated by considering the return in each possible state of the world and then constructing a weighted average, where the weights are our estimate of the probability of each state. Expected values are measured in the same units as the variable itself; by contrast, risk is a way of characterizing the range of possible outcomes, and no single variable completely describes risk. Risk is sometimes summarized by the *variance* of the returns. Risk might also be characterized by the probability of making a net loss, or an estimate of the maximum possible loss, or the variance and skewness of the return. Expected returns and risk measure different types of things and there is no simple way to combine the two into a single indicator.

Other things being equal, people always prefer higher expected returns to lower expected returns. But other things are rarely equal: in practice, we look at both expected returns and the amount of risk that they involve, and we choose a combination of risk and returns that suits us. The willingness to trade off lower returns for lower risk is a signal that the individual is *risk averse*. Most people (and correspondingly most firms) are risk averse to some degree, at some levels of risk and return. In other words, they have to be paid – in the form of higher expected returns – to take risks. Risks can be diversified so that individuals or firms can choose from a more advantageous set of risk-return combinations without affecting the total risk to the community as a whole – the actual probabilities are all unchanged; the larger and more diverse group, the greater the risks it can bear.



Mainstream microeconomic theory revolves around understanding how supply and demand relate to prices. The downward slope of the demand curve indicates that a greater quantity will be demanded when the price is lower. Conversely, the upward slope of the supply curve tells us that as the price goes up, producers are willing to produce more goods. The point where these curves intersect is the *equilibrium*. At a price P producers will be willing to supply Q units and at that price, buyers will demand the same quantity. In this example, there is one equilibrium price which equates supply with demand.

The demand curve therefore shows how willingness to buy varies according to price. When prices change, we move *along* the demand curve to find what quantity people will want to buy at that price. But demand is determined by other factors as well as price, such as the level of income, consumer preferences, the price of substitute goods and the price of complementary goods. If there is a change in any of these determinants of demand, then the demand curve will *shift* on the graph.



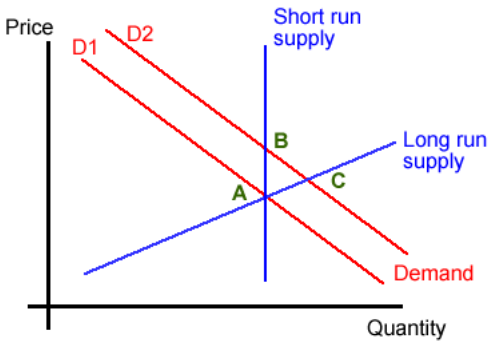
If D1 – the first red line on the graph – shows the demand for a product, then when the quantity demanded at each price rises due to a change in consumer preferences the whole demand curve shifts to the right, to D2. If the supply curve does not change, then the equilibrium prices rises (from P1 to P2), and the quantity produced increases (from Q1 to Q2).

The supply curve shows the quantity that producers are willing to sell at each price; as quantities rise, so firms need to be paid higher prices to make them. Just as a shift in the demand curve moves the equilibrium along the supply curve, so a shift in the supply curve moves the equilibrium along the demand curve. A rise in the cost of labor would move the supply curve upwards, and so the equilibrium would move to the left along the demand curve. The equilibrium price would rise and the quantity bought would fall.

In practice, supply may not be able to change rapidly in response to a shift in market conditions. For example, it may take time to build new manufacturing facilities, train workers, or to assemble the products. These periods of discontinuity – when demand expands more quickly than supply – are often highly disruptive. Again, for a variety of reasons, this may be more likely in developing country markets than in more established industrial market environments.

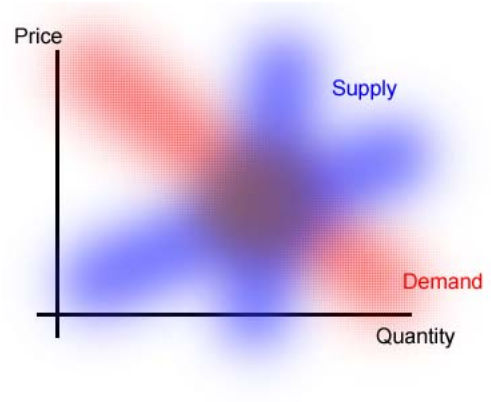
In this situation, the supply curve may be steep – possibly vertical – in the short run. The quantity of goods that can be produced and sold is effectively fixed in the short run. When demand increases, the price may rise but there is no immediate change in the quantity that is produced and sold.

In these circumstances, an increase in demand (from D1 to D2 on the diagram) leads to a movement up the short run supply curve at first, from A to B. If the increase in demand is expected to be sustained, then in the long run suppliers can adapt to higher demand, and the equilibrium shifts from B to C. Prices rise at first, and then fall back as supply increases.



Note that the long run supply response depends largely on *expectations* of what will happen in the future. Uncertainty about future demand therefore makes a significant difference to the probable supply response.

Many of the determinants of the supply and demand functions are not known with certainty. On the demand side, there is uncertainty about incomes or budgets of purchasers, tastes, and the prices of complementary and substitute goods. On the supply side, there is uncertainty about costs of inputs such as labor, and uncertainty about the technology that will be available to translate those inputs into the required output. We will look at those causes of uncertainty later.



Uncertainty and risk about the position of the demand curve lead to uncertainty about where equilibrium will lie on the supply curve. Conversely, uncertainty and risk about the determinants of supply leads to uncertainty about where the equilibrium will lie on the demand curve. Together, these uncertainties can lead to a potentially large set of possible outcomes. This means that both prices and quantities demanded and supplied are highly uncertain, and could vary considerably depending on the actual position of the supply and demand curves.

If all economic agents were risk-neutral, or could fully diversify their risks, then they would only take account of the expected returns from each option and they would not care about the risk. But if firms or customers are risk-averse, then they will be willing to forego some expected returns to secure lower levels of risk. In other words, the existence of undiversified risk imposes a cost on risk-averse economic agents.

There are several classes of risk that might affect the location of the supply curve in markets for global pharmaceutical products and diagnostics:

- *R&D risks:* A long-term supply risk is whether a product is successfully developed at all or if it fails during clinical trials.
- *Batch failures*: A short-term supply risk is that a firm produces batches of products that fail tests for effectiveness, uniformity or safety due to a failure in a process, component, system, or because of personnel error.
- *Supply chain failures:* Health products may depend on intermediate products from other suppliers, and uncertainty in the supply of these other products will affect the supply of the final product.

- *Credit risk*: The possibility that a borrower, supplier or customer might fail to honor its contractual obligations. In the pharmaceutical market, this may be quite pronounced if the contractual obligations are weakly enforced – again, a feature of developing country markets
- *Regulatory risk:* For many suppliers, a key risk is that the regulatory regime will change, or that it will be applied in unexpected and possibly capricious ways. This includes the WHO recommendation and prequalification process, and national regulatory procedures for licensure and/or registration.

The main demand-side risks relate to funding, public sector demand and the bargaining power of public sector purchasers:

- *Budget and purchasing power risks*: Volatility in donor budgets for global public health lead to volatile and unpredictable demand. Furthermore, if developing countries pay for some or all of the costs, volatility of domestically financed health budgets may also impact the position of the demand curve.
- *Bargaining risk*: Public sector purchasers are often the main or only purchaser of medicines or diagnostics for their jurisdiction, and they may collaborate across countries to secure lower prices through greater bargaining strength. If suppliers have to invest in production without a binding pre-commitment from purchasers, then the buyers have an incentive subsequently to negotiate down the prices once the investment is sunk.
- *Competition risks*: Some products benefit from a temporary period of exclusivity through intellectual property protection and others face little competition because of the complexity of production or regulatory barriers. But where there are alternative products that can produce health benefits, the price and availability of these products can made a significant difference to demand for a company's product.
- *Obsolescence risks*: A long-term demand risk for some products is that they are made obsolete – for example, because a better alternative is developed, or because another approach is adopted for the condition.
- *Policy and preference risks*: Adoption of medical technologies is frequently dependent on a range of uncertain determinants, such as availability of data about the burden of disease, public attitudes to the disease, understanding of the range of interventions, and stigma and understanding about the particular product.
- *Complementary input risks*: Complementary inputs are required for product usage, including skilled personnel to diagnose conditions and to administer treatments, physical infrastructure such as clinics and roads, supply chain and logistics capacity, controls on corruption and theft, and the capacity to plan, budget and manage the introduction and use of new medical interventions. Under severe resource constraints in a health system, as an increasing number of products are introduced, the potential to deliver each of them may be compromised.

Genuine risks and uncertainty characterize the past, present and future, and must be taken into account in any decisions that affect supply and demand.

In principle, three types of approaches can reduce the cost of uncertainty:

1. Reducing uncertainty and risks by making more information available to decision makers
2. Diversify risk to reduce its costs or hedge in financial markets

3. Allocate remaining risks to the stakeholder that can bear them at least cost

From the point of view of the costs and risks borne by the community, it is better first to reduce uncertainty wherever it is cost-effective to do so. Remaining risk should be diversified by pooling or hedging. Remaining risks should then be allocated to the stakeholder best able to minimize and bear them. The table below sets out on a very broad canvas the main risks, and the most promising avenues for reducing them or managing their impact.

Risk	**Reduce uncertainty**	**Diversify risk**	**Allocate remaining risk to:**
Batch	Improved production systems	Self-insurance by producers	Producers
Supply chain	Contractual arrangements	Producers seek alternative suppliers	Producers
Regulatory	Stable & predictable regulation Supranational regulators		Regulators
Budget	Predictable aid Medium term budgeting Improved sharing of information for demand forecasting	Demand pooling	Donors Developing country governments
Bargaining	Long term contracts Purchase commitments	Reduce monopsony	International organizations
Competition	(Benefits of competitive pressure outweigh costs)	Investors or producers may diversify portfolio Industry risk pooling	Producers
Obsolescence	Open publishing of scientific data	Producers may diversify product portfolio	Producers
Policy & preference	Sustained investment in advocacy and education Improved mobilization and sharing of information for demand forecasting	Take-or-pay contracts	Developing country governments

Appendix C. Supply Chains for Developing Country Health Products

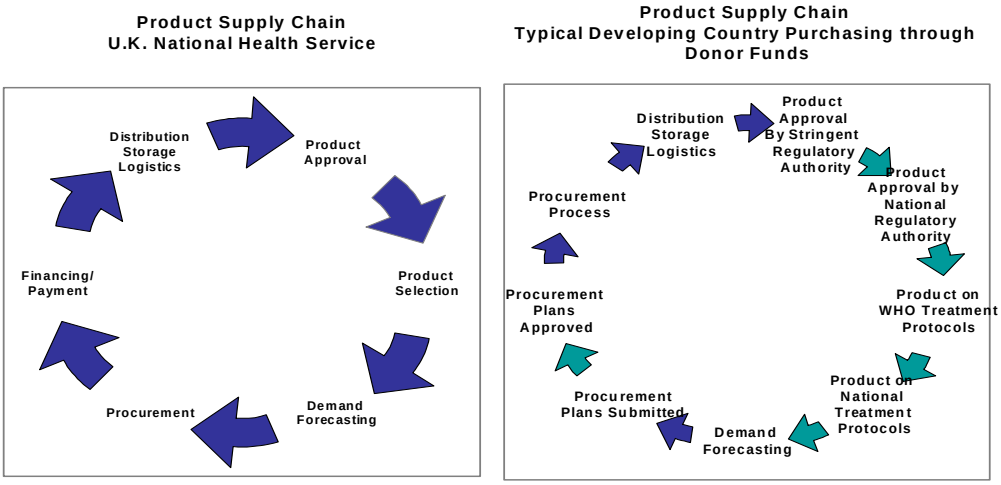
Supply chains in health care are some of the most complex of any industry. Unlike many other global commodity chains, they must cope with fluctuating demand from changes in patients' needs (including tolerance, resistance and unexpected outbreaks), short product life spans, frequent product innovations with uncertain uptake patterns and demand, and susceptibility to disruptions from economic, political, trade regime and regulatory changes in developing countries, which are often suppliers of raw materials and intermediary products.[57] Manufacturers and purchasers must finely balance efficiency with availability because shortages cost lives and come with significant political and economic consequences.

While these challenges exist in both developed and developing countries, historically higher levels of health spending and the existence of third-party payers in developed markets has allowed manufacturers and buyers to use responsive, higher-capacity supply chains and excess inventory to buffer against market uncertainties. In recent years, the use of excess inventory has become more restricted even in developed markets as a result of the U.S. Sarbanes-Oxley legislation, which prevents drug companies from producing inventory above forecasts to counter "dumping" in the market.[58]

Developed markets are also characterized by relatively good information and market research, in part because more money has been invested for information-gathering. Developed markets also have purchasers and suppliers with established relationships and balanced market power.[59] For example, the U.S. pharmaceutical market (the largest in the world, accounting for 44% of all sales in 2003) has three wholesalers who cover 90% of the wholesale market.[60] Wholesalers are the major private sector customers of manufacturers, spending $212 billion in 2004.[61]

Developing country markets are nascent and much more complex. Data are limited and unreliable, few tools exist to gather good market research, and both money and human resources are in shorter supply. At the same time, disaggregated and small purchasers, and multiple layers of international and national decision makers, make the process more uncertain and more expensive for manufacturers and buyers. In addition, health goods are delivered by multiple supply chains including public, non-profit or NGO, formal private and informal sector. For many products, such as those used to treat malaria, public sector supply chains are not the most dominant ones.

For the purposes of this discussion, we contrast two public sector supply chains: one in a rich country market, the National Health Service (NHS) in England, and one in a typical low- income country, purchasing with donor financing. The sad consequence of these differences is that a child in Zambia, for example, must wait at least 3½ years longer than a child in the U.K. to get access to a life-saving treatment in the public sector, even when money is available.



What causes these differences at each step of the supply chain?

1. Product Approval:

The large and lucrative NHS market (GBP 8.1 billion in 2005 and growing at an annual rate of 10.8%)[62] makes it attractive for manufacturers to have their products registered for use in the U.K. If the drug has been manufactured outside of the U.K. by a PIC/S approved regulatory authority,[63] sharing of standards and dossiers between regulatory agencies make the approval process straightforward through the U.K.'s Medicines and Healthcare Products Regulatory Agency (MHRA).

In contrast: If the developing country has a small market, the manufacturer may not have registered its drugs for approval by the national regulatory authority in the country. Unlike PIC/S approved authorities, requirements for dossiers are not consistent or shared among all countries. This makes the approval process for a supplier much longer, more complex and more expensive. Even if the drug has been approved for national use, most donors require approval from a PIC/S registered regulatory body or the WHO.[64] WHO is a new player in the product approval process and has recently begun to pre-qualify products for developing country markets. Their pre-qualification processes are under development and the relationships with PIC/S approved authorities are beginning to be established.

Once a supplier has requested country approval, the in-country registration process can take an additional 6-12 months.[65] This can mean that even if multiple suppliers exist globally, many countries have access to only a single supplier. Some manufacturers cite these regulatory barriers as the single greatest hurdle to wider access to drugs in low income countries.

2. Product Selection:

In the NHS, after the manufacturer obtains approval of its drug from the MHRA doctors are free to prescribe it without further authorization from an NHS body or purchasing agency. There is no "white list" of approved drugs that can be ordered.[66] This is changing though with the development of treatment guidelines by the National Institute of Clinical Excellence (NICE), and by regional technology assessment agencies; while these guidelines are not mandatory, they are increasingly

being monitored by oversight bodies and considered in resource allocation decisions.

In contrast: Donors generally approve purchase of drugs that follow internationally recognized treatment guidelines (usually developed by the WHO). These guidelines are created through processes which bring together international experts in "informal consultations" on an ad hoc basis.[67] Experts examine clinical evidence on the usefulness of the drug based on trials in developing countries, which are often not funded by manufacturers, prolonging the time needed to prove the drug's effectiveness on the ground. At the country level, national treatment protocols must be revised before the drug can be purchased with public monies, a process that can take 6-12 months. Separately, most developing countries have essential drugs lists (EDL) based on the WHO EDL and require that drugs procured by public funds are on these lists.[68] The WHO EDL is updated every two years in a process distinct from that used to create treatment guidelines. Changes in treatment protocols and prequalification can have a profound effect on the demand for branded versus generic drugs, prescribing patterns and overall drug costs.

3. Demand Forecasting:

In the NHS, national demand forecasting is done through a specialized technical body of the NHS called the Purchasing and Supply Agency (PASA). PASA works with suppliers to forecast demand and establishes long term framework contracts through which NHS Hospital Trusts procure drugs and supplies.

In contrast: National and local demand forecasting systems in developing countries are often weak or non-existent. Although donors typically require procurement plans specifying which drugs a country will order and their purchasing timeframe, the quality of these plans varies. The dearth of good epidemiological data and consumption information, lack of trained personnel, and political pressures to achieve targets add high levels of uncertainty to these plans. In recent months, due to supply shortages and recognition of the importance of demand forecasting, various departments in the WHO have started to create aggregate needs and demand estimates for particular drugs; for example, the Roll Back Malaria Partnership with WHO has begun demand forecasting for new malaria products and the WHO AIDS Medicines and Devices Service (AMDS) is starting work on forecasts for first line ARVS. In addition, the Clinton HIV/AIDS Initiative already creates demand forecasts for ARVs to negotiate price agreements with generic suppliers, and will begin to play a similar role for ACTs.

Procurement agents such as UNICEF, IAPSO, Crown Agents, and Mission Pharma will also create demand forecasts for their customers. However, their planning horizons are often very short and procurement agents may not be able to provide 12-month rolling forecasts to manufacturers. In addition, the bidding process between agents and countries may result in double counting of demand, for example when multiple agents place orders based on unconfirmed bids. Government tendering processes can complicate these problems.

4. Procurement:

For drugs prescribed in NHS hospitals, PASA negotiates contracts and prices with suppliers; NHS hospitals order independently, based on these rolling long term (typically 4 year) agreements. PASA uses sophisticated electronic analytical tools to obtain the optimal price to encourage

competitiveness and ensure drug availability.

In contrast: Most procurement in developing countries is conducted through rigid, paper-based competitive tender processes. Long term agreements sometimes exist, but typically with terms that yield neither significant pricing benefit to buyers nor increased certainty for suppliers. The bidding process itself can take from 6-9 months, and negotiators are often civil servants with limited training in contracting. Products can be available more quickly if international procurement agents are used, but agents usually negotiate only one-year agreements with suppliers and charge countries high fees (often 3% - 16% of product value).[69]

5. Financing and Payment:

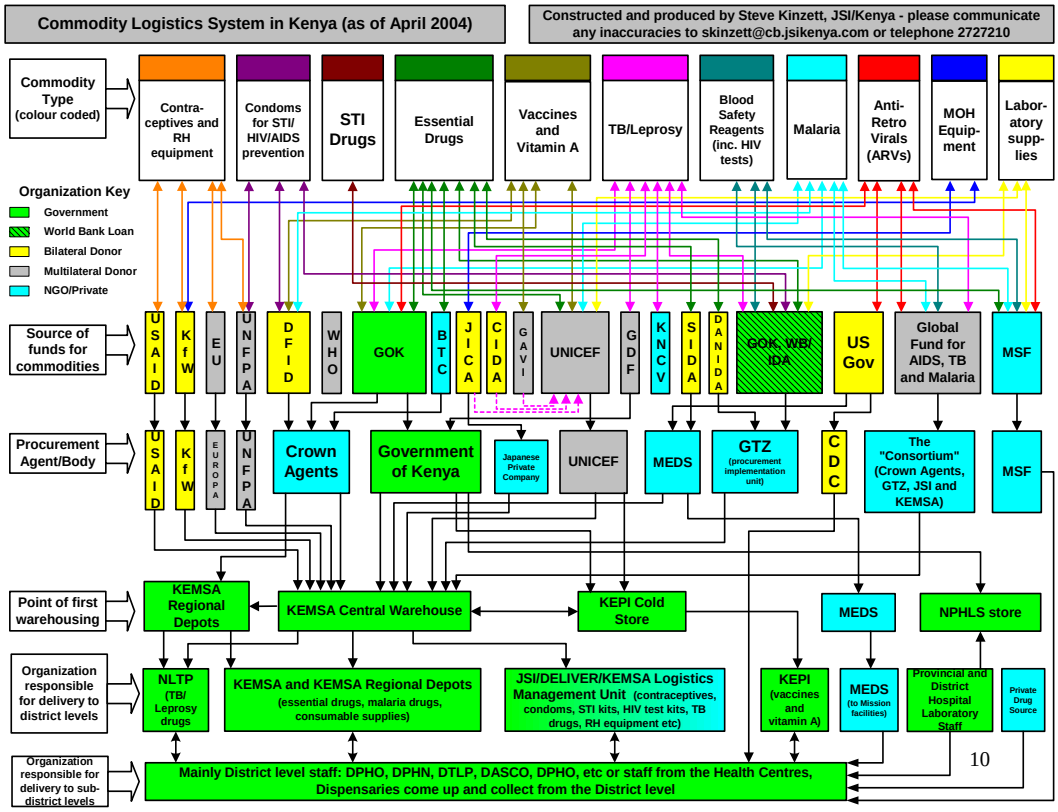
In the NHS, once the hospital orders the drug, payments can generally be handled electronically. Financing is based on pre-established budgets. A new case rate payment system is being introduced for hospitals which may impact the prescribing patterns of physicians, but is unlikely to affect the electronic payment process for drugs.

In contrast: While some donors undertake pooled procurement (e.g. the GAVI Fund, USAID), arrangements where products are purchased directly by countries are more common (e.g. the World Bank, most Global Fund grants). To release funds from a donor to a country for purchasing products requires multiple checks. Once funds are released, bureaucratic processes in-country, involving several ministries and layers of approval, can further delay financing approval, and consequently the ordering of necessary drugs and supplies. Even once drugs are received, uncertainties around costs for taxes, duties and customs can create delays. Insufficient budget planning for these additional costs, can mean that products can be held up in customs for months awaiting release of funds. Many procurement agents and companies also require partial pre-payment on orders, which may be difficult with current donor processes.

6. Distribution, Storage and Logistics:

In the NHS, contracts with manufacturers specify that they must deliver drugs to hospitals directly or via a specialist distributor. For products other than pharmaceuticals, the NHS has established an arms-length logistics agency which specializes in these functions. The contract for managing this agency was recently awarded to DHL.

In contrast: Difficulties in transportation, storage capability and logistics expertise make this a very cumbersome process in many developing countries (as illustrated below), which depicts the complex commodity logistics system in Kenya. The chart is included less as an illustration of the specifics than as an example of the general observation of the complexity of logistics systems in developing countries and how those complexities are exacerbated by multiple donor funding streams. Much has been written on in-country logistics issues and several donors are investing in strengthening distribution capacity.[70,71] JSI and MSH, among others, are also very active in assisting countries to improve logistics once products reach the country. The costs of distribution, storage and logistics can be very high and typically, these recurrent expenses are not funded by donors. One study in Ghana for example, estimates that the direct costs of the logistics system for drugs ordered through the Ministry of Health (MOH) is 13% of its total MOH budget; an astonishing 73% of this is for storage and warehousing.[72]


Commodity Logistics System in Kenya (as of April 2004)
Constructed and produced by Steve Kinzett, JSI/Kenya - please communicate any inaccuracies to skinzett@cb.jsikenya.com or telephone 2727210
Commodity Type (colour coded)
Contra-ceptives and RH equipment
Condoms for STI/ HIV/AIDS prevention
STI Drugs
Essential Drugs
Vaccines and Vitamin A
TB/Leprosy
Blood Safety Reagents (inc. HIV tests)
Malaria
Anti-Retro Virals (ARVs)
MOH Equip-ment
Labor-atory supp-lies
Organization Key
Government
World Bank Loan
Bilateral Donor
Multilateral Donor
NGO/Private
Source of funds for commodities
USAID
KfW
EU
UNFPA
DFID
WHO
GOK
BTC
JICA
CIDA
GAVI
UNICEF
GDF
KNCV
SIDA
DANIDA
GOK, WB/ IDA
US Gov
Global Fund for AIDS, TB and Malaria
MSF
Procurement Agent/Body
USAID
KfW
EUROPAA
UNFPA
Crown Agents
Government of Kenya
Japanese Private Company
UNICEF
MEDS
GTZ (procurement implementation unit)
CDC
The "Consortium" (Crown Agents, GTZ, JSI and KEMSA)
MSF
Point of first warehousing
KEMSA Regional Depots
KEMSA Central Warehouse
KEPI Cold Store
MEDS
NPHLS store
Organization responsible for delivery to district levels
NLTP (TB/ Leprosy drugs
KEMSA and KEMSA Regional Depots (essential drugs, malaria drugs, consumable supplies)
JSI/DELIVER/KEMSA Logistics Management Unit (contraceptives, condoms, STI kits, HIV test kits, TB drugs, RH equipment etc)
KEPI (vaccines and vitamin A)
MEDS (to Mission facilities)
Provincial and District Hospital Laboratory Staff
Private Drug Source
Organization responsible for delivery to sub-district levels
Mainly District level staff: DPHO, DPHN, DTLP, DASCO, DPHO, etc or staff from the Health Centres, Dispensaries come up and collect from the District level
10

Appendix D. Forecasting Principles

The principles below are grouped by the three categories listed above. Under each principle is a description of the principle and its purpose, and a section on application of the principle, with examples of how the principles have been used in practice are provided in separate text boxes.

I. Customer Focused

1. Identify the principal customers/ decision-makers of the forecast and clearly understand their needs.

Description and Purpose: Identifying the key customers and understanding how they will use the forecast is an important first step in the forecasting process. If the purpose of the demand forecast is to estimate the appropriate supply of products, then suppliers will be important customers of the forecast. It is therefore important to understand the needs of the suppliers and the environment in which they are making production and investment decisions. If the purpose of the forecast is for procurement or distribution key customers will be health program managers, procurement agents, supply chain managers, and funders. It is important to understand their needs, time horizons and at which stage they will be making certain decisions.

Application: Meet with key decision-makers (those within your organization and the ultimate customers) to jointly define the forecasting problem, and understand what purposes the forecast will serve. Determine the time frame for which the forecast is intended; for example, is it a short-term forecast for supply chain/ordering decisions, a long term product development forecast, or a forecast to inform mid-range investment decisions? Obtain agreement on the level of engagement that customers/decision-makers would like in the process.

In some cases, different customers will require forecasts for very different purposes with varying time horizons and levels of accuracy. This requires separate forecasts and forecasting processes. Each of these forecasts should be independently specified with customers and their needs clearly defined.

Good practice suggests that discussions take place in face to face meetings with the users of the forecast to probe their needs in detail. These should be explicitly confirmed in writing before the forecasting process begins.

2. Understand and clearly communicate the purpose of the forecast and the decisions that it will affect.

Description and Purpose: Forecasts are only necessary if they can affect decision making. If decisions won't change as a result of the forecast, there is no economic justification for forecasting. Understanding the specific decisions that will be affected by the forecast and the timing of these decisions is critical if the forecast is to have any real impact.

Application: Meet with decision-makers to agree on which decisions will be affected, how the forecast will inform these decisions, and the specific circumstances under which they will change their decision based on the forecast. Understand their detailed needs, including interrelationships with other decisions, level of aggregation required, time frames, important geographies on which to focus, and analogous forecasts that should be considered.

One approach is to present forecasts under different possible conditions to produce distinct options for decision makers. For example, *"if the facility is built at a capacity of Q, the price would have to be P, and we forecast that demand at that price is significantly lower than Q, which means a build-up of inventory, so we shouldn't make the*

investment; however, if the facility is built to a larger capacity and efficiencies permit us to charge a lower unit price, and we forecast that demand at the lower price matches the higher capacity, we should consider making the capital investment."

Document all decision parameters in writing.

3. Create a forecasting process that is independent of planning and target setting.

Description and Purpose: Forecasts are not plans and they are not targets. A forecast is how the future is likely to look, whereas plans and targets are how we would want it to look. Credibility and trust in the forecast and the forecasting process are compromised if it is based on plans, goals and targets. However, plans will serve as inputs to forecasts and will also be influenced by them. While there is a mutually reinforcing feedback loop between planning/marketing/distribution and forecasting, these should be considered distinct processes.

Application: This can be a difficult principle to implement in practice because of the necessary interdependence between planning, marketing, goal setting, and demand forecasting. As a rule of thumb, forecasts should drive planning to a greater extent than the other way around.

Within an organization separating the demand forecasting process from planning processes, and having different people perform these functions is a good way structurally to ensure greater independence. At the same time, ongoing and explicit feedback and data loops between these functions must be built into the structure.

One method for addressing management's desire to accommodate plans, sales goals and targets into forecasts is to generate separate forecasts for alternative plans or targets and present these in concert with plans. For example, "*if we achieve 80% of the target, demand for this ACT is likely to be 160,000; if we achieve 90% it is likely to be 200,000. The likelihood that we will achieve 80% of the target is 70%, whereas achieving 90% of the target has only a 50% chance."* This allows decision-makers to understand and balance their risks in the context of other priorities. It will also allow procurers to decide how much risk they are willing to take in their orders.

All 'adjustments' to forecasts should be based on evidence of justified opinion, and always supported by documented rationale.

4. Protect the forecasting process from political interference and ensure it is transparent.

Description and Purpose: Political issues surrounding forecasts are often difficult to disentangle from the need for demand forecasts in the first place. Some may argue that because markets for global health products function within and are influenced by global, regional and national politics, public sector programs, and lobbying, politics is inherent to the process of forecasting for these products and should not be disassociated.

Clearly the political and policy environment influences the demand for health products either directly or indirectly and therefore its impact must be considered. While these factors should be explicitly taken into account as process drivers or assumptions in *developing* the forecast, political considerations should not be used to *change the results* of the forecast. Adjustments or "fudges" should not be made to forecasts simply because the results of the forecast do not meet political objectives (e.g. what our Minister say the demand "should" be or what the sales department wants demand to be).

If the purpose of the forecast is to give customers as objective a sense as possible of future demand then its credibility is compromised if they believe the forecast is serving political objectives, providing a tool for advocacy, or trying to generate additional resources.

Application: To deal with political considerations, it is helpful to map the political issues surrounding the forecast and the forecasting process, and develop a strategy to manage these. Explicitly documenting political pressure to influence inputs or final forecasts and identifying the likely impacts of these inputs is also useful to protect the integrity and transparency of the forecasting process.

Changes and inputs should be rationally justified, supported by evidence (quantitative or qualitative), agreed upon and documented.

II. Process and Context Focused

5. Embed the forecast into the broader environment taking into account market conditions, public policy, competitive forces, regulatory changes, health program guidelines.

Description and Purpose: Forecasts should be an expression of market knowledge and as such whenever a forecast is presented, the audience should gain a clear understanding of the wider market context. The quality of the forecast is more dependent on the extent to which forecasting is carried out as part of a broader analytical process rather than complex models and methodologies. When a forecast is developed with insightful market understanding this will be apparent and the results communicated and understood by a wide audience.

Application: While it is a distinct process, forecasting should not be carried out in isolation from other functions. A cross functional matrix team approach should be adopted to optimize efficiency. The individual responsible for developing or updating a forecast should work in collaboration with those responsible for other analytical activities including those active in market and policy development.

In the case of a PDP for example which has several products under development that may compete with each other, creating forecasts for a single product launch should include managing the entire product portfolio strategically by modeling the impact of different demand scenarios of these products together, including potential timing of introduction, price points, and other product characteristics.

6. Create a dynamic forecasting process that continually incorporates and reflects changes in the market, public policy and program capabilities.

Description and Purpose: Demand forecasting is an iterative process that is influenced by external drivers and changes in the capabilities and requirements of health programs. Forecasts are an important input into the decision-making process and should change as the environment changes. Identifying key market, policy and capacity drivers and as they change ensuring that the forecasting process incorporates these changes on a continuous, agreed upon schedule is an important component of forecasting. For this to happen efficiently the critical drivers and assumptions should be highlighted and monitored closely.

Application: The use of rolling forecasts (e.g. updating forecasts for the next 18 month period) is standard practice. The most important demand drivers should be identified and monitored and reported to reflect changing market conditions and new information. Strategic forecasts are frequently updated annually or more often depending on need. Operational forecasts can be updated monthly, quarterly or more frequently as needed.

A governance process for forecasts should be defined. It is also important to incorporate an ongoing evaluation process to measure the accuracy of forecasts against actual results. This analysis should identify key causes of errors so that the process and variables used in producing the forecast can be continually refined. A commonly used practice, particularly closer to product launch when risk is high, is to seek

external validation and have an outside agency (e.g. market research firm or econometric group) repeat the forecast to ensure consistent results.

For health programs, forecasting processes will be tightly and iteratively linked to distribution strategies; as the forecast changes the distribution strategies should change to reflect this and vice versa. If these processes are out of sync, shortages and expirations at point of patient care are likely to occur even with an adequate supply of product.

Coordination of Demand Forecasting at the Country Level
In Zambia, there has been a concerted effort to improve coordination of forecasting at all levels. Implementing partners of the HIV/AIDS programs jointly agreed to create a national forecast for anti-retroviral therapy (ARVs). This forecast provided the basis for discussions with the various funding sources to ensure that there was sufficient funding to cover forecast needs. The partners also reported information on their issues to facilities, their stock on hand, and their planned shipments. This provided a picture of the national stock situation. All partners are using procurement management software, PipeLine, to facilitate the timely sharing of key information, including months of supply by product. By sharing information, the partners can enhance their coordination and take concrete actions to ensure product availability. For example, one partner had 50 months of Efavirenz, 50mg, almost guaranteeing expiration and waste, while another partner was stocked out. The partners were able to transfer stock, which allowed the stocked-out partner to meet the demand for Efavirenz, 50mg, and to cancel future shipments until the stock within the country was used, thereby lessening the chance of expiration. (USAID/Deliver. Delivering HIV/AIDS Products to Customers: Lessons in Supply Chain Management. Virginia. May 2006.)

III. Methodology and Data Focused

7. Choose the methodologies most appropriate to the data and market environment. Obtain decision-makers agreement on the methodologies to be used.

Description and Purpose: Different forecasting methods are appropriate under different circumstances. If the environment has sufficient cross sectional and time series quantitative data and the environment is stable, then a variety of quantitative analytical tools can be used. If large changes are anticipated, historical data will need to be augmented with causal models and expert analyses. In many cases, in the current global health environment, quantitative data are limited and large changes are expected in funding or policy. In these cases it is necessary to collect and analyze qualitative or 'judgmental' data using a variety of methods such as Delphi, prediction markets, role playing, structured analogies and game theory.[c] Applying these methodologies requires considerable knowledge and skill; these are best used by those with training in gathering and understanding these types of data and forecasting methodologies.

In many cases, several methodologies will be appropriate for the forecasting problem. It is useful to develop forecasts using several different methods to improve forecasting accuracy.

Gaining acceptance of forecasts requires that decision-makers understand the methodologies selected and their limitations and strengths.

Application: List the important selection criteria before selecting the methods for forecasting. Perhaps ask unbiased experts to rate the methods. In new product markets, creating market analogs which look at other products with similar characteristics to understand uptake speed and switching rate from existing products is a commonly used technique. Analogs can be based on products launched in similar therapeutic classes, with similar orders of entry, and by companies with similar promotion budgets. Analogs can also be used to identify sub-markets, and regions or countries that may behave similarly.

[c] For a comprehensive description of forecasting methods see J. Scott Armstrong's *Principles of Forecasting: A Handbook for Researchers and Practitioners.*

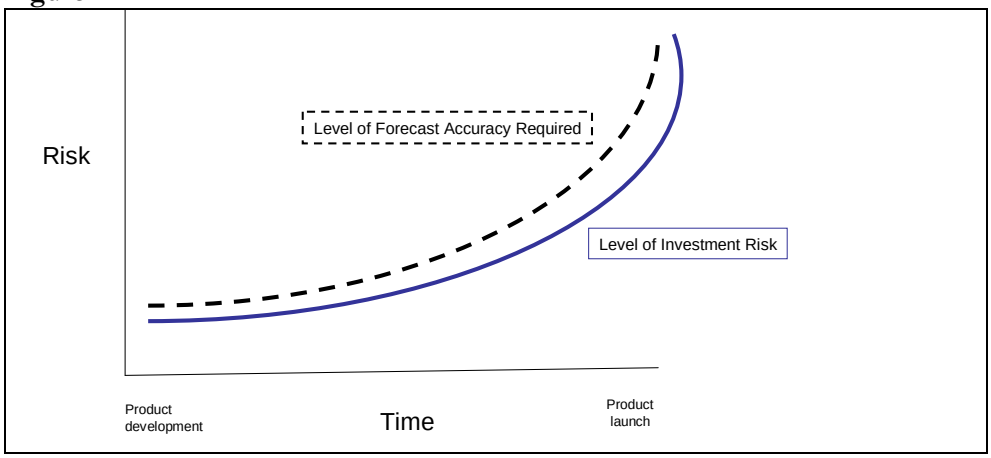
Describe how the forecast will be made to decision-makers in understandable terms and obtain agreement on how you will approach the forecasting process and the methods that will be acceptable to them.

The Use of Banding in Immunization Forecasts
In projecting immunization demand, the WHO Global Immunization Program grouped countries into bands by size and wealth focusing on the rate of adoption of a global program within each band. Initially, it was assumed that larger and wealthier countries would adopt more quickly and smaller and poorer countries would adopt later. These initial groups were modified as the program progressed so that banding became more accurate with time and was based on a variety of characteristics beyond simply size and income level. When using the banding strategy to determine rate of adoption, it was useful to consider India, China, and South America separately. These countries/regions are influenced by global programs but usually act based on local data and may choose a variation of the global program. The Global Immunization Program has created several models which all show that even with a good infrastructure in place and few funding problems a 70% take up requires about 8 years. However immunization is a preventive strategy rather than a curative strategy. People may be more motivated when they are sick or threatened immediately, for example, meningitis vaccination can achieve levels of 50% coverage from 0% within a matter of weeks during an epidemic.

8. Keep the methodology simple and appropriate to the situation. Don't introduce too much complexity, but include sufficient detail to address the investment risk and level of accuracy required.

Description and Purpose: *"It is better to be broadly right than precisely wrong."* The level of accuracy needed in forecasts increases as the time horizon shortens. The level of confidence in the forecast is proportionate to the investment decisions and associated risks; for example, ordering forecasts will require a much higher level of accuracy and certainty than strategic long term forecasts (as shown in figure 2).

Figure 2



When producing strategic forecasts, understanding the level of uncertainty is critical. These types of forecasts are 'best guesses' of how the future will look in 10-20 years and giving a false sense of accuracy can be misleading and counter-productive, actually decreasing customers' confidence in the forecast.

Application: Make sure the forecast is appropriate to the level of investment risk being undertaken and the decisions that will be made based on the forecast. For example, a strategic forecast might involve interviewing 50 stakeholders; while a short term purchasing forecast might involve interviewing hundreds of stakeholders to get precise information on timing of orders, demand and price considerations.

Clearly identify the confidence level of the forecast and provide explicit confidence intervals if possible. If qualitative judgments are being used in which it is difficult to provide statistical intervals, simple low, medium and high estimates may be necessary. However, even in these cases it is important to try to estimate the likelihood of achieving each of these estimates (e.g. there is a 50% chance that we will hit the medium forecast but a 90% chance that will hit the low estimate). In early stages of a product life cycle, for example, forecasters may decide to use the lower deciles in the confidence range of forecasts as the baseline, rather than the mid range forecast, as making conservative assumptions in these cases will give greater credibility to forecasts. However, very conservative estimates all along the supply chain can lead to shortages, which can have serious public health consequences. Manufacturing investment forecasts, for example may need to use the higher estimates.

It is important to be explicit about the level of uncertainty in the forecast so that those who use the forecast understand how much they can realistically discount it (or not). Higher levels of uncertainty will require increased levels of flexibility across entire supply chains including procurement, distribution, manufacturing and sales processes.

In situations of high uncertainty or very small or large numbers, the forecasting problem might be decomposed into its component parts and each part may be forecast separately with the results combined at the end. One way to do this is geographically for example, in the early uptake of a new product, it is better to build bottom-up forecasts on a country-by-country basis and aggregate these to determine the global forecast rather than looking at aggregate trends.

Regular monitoring and evaluation is also very important: the more uncertain the forecast, the more often it should be checked against actual demand and the more frequently it should be revised.

Demand Forecasting in Health Programs
Typically a demand forecast will start with scan or assessment of the program situation, and an appraisal of the current conditions and performance. This will include consideration of products, distribution channels, and an assessment of a health program's political and technical elements that are necessary pre-requisites for changes in use of products and supplies. The assessment should also provide a realistic assessment of the characteristics of products – their stability, shelf life, turn over rate, side effects, controversies around use, ease of manufacture, simplicity in re-supply, etc. Data on implementation plans, targets, objectives and goals can then be fed into the equation to assess likely changes from historical trends. In addition to providing the key inputs into the forecast, these factors will inform the frequency and horizon of the demand forecasting process.

9. Make forecast assumptions clear and explicit.

Description and Purpose: To ensure acceptance of forecasts, it is important that decision-makers understand the basis for the forecasts as well as the key drivers and risks to which the forecast is particularly sensitive. Forecasts should provide an accurate representation of the current situation and should continually change as these conditions change.

Application: Explicitly identify key drivers of the forecasts by using theory and domain expertise to define causal links and risks. In specifying key drivers, limit irrelevant variables and don't select variables simply based on statistical techniques such as step wise regression or data mining. These techniques can yield spurious relationships between variables that do not have face validity.

Funding flows and the timing of these flows will often be key drivers in forecasts for global health products. Capacity constraints, human resources, available instruments and plans and policies of various agencies are also relevant. The forecasting process should recognize which drivers are most critical at a particular point in the life cycle of the product and the program, and continually update and refine the

drivers and their inputs. For example, early in a health program, the amount and timing of funds may have a more critical impact on the forecast, while later in the program, availability of human capacity may be the most significant driver.

Test with key contributors and users of the forecasts that all relevant players have the same understanding of the key assumptions and their implication for the forecasting process and output. Particularly in global forecasts, language and culture can create serious misunderstandings in assumptions and their impact.

Ensure that each new forecast has clear and documented statements on the changes in assumptions compared to previous forecasts and explicitly quantify the impact of these changes. Date stamp all forecasts.

International AIDS Vaccine Initiative (IAVI) Determining Drivers

IAVI started its forecasting project by identifying the key determinants or drivers of demand. Some of these drivers are largely independent of disease area and can be used by any health program.

- *Need: Potential Recipient Populations*
- *Vaccine Profile: Vaccine Characteristics Specification*
- *Political Will & Access: Regulatory Hurdles, Health System Capacity & Effectiveness*
- *Attitude: Vaccine Acceptability*
- *Funding: Government & Donor Budgetary Constraints*
- *Targeting: Vaccination Strategy*

10. Understand data and their limitations. Use creativity and intelligence in gathering and introducing data into forecasts. Incorporate qualitative inputs rigorously and systematically.

Description and Purpose: The data do not always 'speak for themselves' or if they do, it is sometimes hard to know what they are saying. Understanding which data to collect and how to use these data form the underpinning of good forecasts. Using theory and research to decide which key data elements to collect are the first stage. For example, short term demand forecasts that will influence sales are often based on market size, ability to purchase, and underlying need. These may be the most critical variables on which to focus first; measures such as income, availability and price can be added to refine forecasts.

It is also important to understand the sources of data and the particular biases of each source. Identify these biases before analyzing the data, particularly in health care where those who collect data may intend to impact policy and funding based on their information. Data collected for advocacy purposes to emphasize the importance of a disease and secure more funding for its treatment may be subject to biases that will need to be clearly addressed when applying these numbers to demand forecasts.

Application: If it is difficult to find unbiased sources for core data, it is best to find multiple and diverse sources with differing biases. For example, in looking at epidemiological data, it is useful to get data from a variety of sources with different estimates. While it can be difficult to deal with conflicting data, forecasts will be more accurate if data from a range of sources are combined, giving a better estimate of the actual prevalence and incidence of the disease. Although this may seem counter-intuitive, averaging and combining can be powerful statistical tools if they are appropriately applied. If forecasts are to be used for decisions requiring high levels of investment, primary market research will be required.

Explicitly reference the sources of data, their context and limitations. Check data for face validity by having impartial experts independently review the data and outputs to see if they are relevant and appropriate.

Continual Updating of Data and Assumptions
In Zambia, in the absence of data, consultation with experienced providers for the provision of first line ART (anti-retroviral therapy) informed the estimated uptake of ART and the breakdown of patients by first line regimen. Because assumptions were based on providers' experience, the forecast for first line ARV drugs was relatively accurate. However, because the program was relatively new, the providers' experience with second line treatment was limited. Thus, the assumptions were less informed by experience and relied more on expectations, thus leading to an overestimate in forecasting consumption for second line ARV drugs. Procurement planning was based on those assumptions— weak as they were—because of the lack of any kind of data. Fortunately, as a result of careful monitoring of consumption, a second line drug shipment due in six months was postponed, preventing a number of expensive, second line ARV drugs from expiring in the warehouse. Frequent reviews and adjustments to a quantification, which are based on actual consumption, allow programs to respond to rapidly changing environments. (USAID/Deliver. Delivering HIV/AIDS Products to Customers: Lessons in Supply Chain Management. Virginia. May 2006).

Appendix E. Information Sharing & Gathering as a Public Good

Good information plays a critical role in the development of accurate demand forecasts, not only in global health, but in any industry where projections of future product demand determine expectations for future investments in manufacturing capacity, sales and marketing efforts, or other such commercial investments. Access to more reliable and comprehensive data has the potential to significantly improve forecasting accuracy and to provide all stakeholders in a supply chain with a common understanding of market potential. Furthermore, the improved forecasts that result from better information reduce the likelihood of product shortages, delivery delays and overproduction – all of which engender significant costs (financial and otherwise) to suppliers and end-users. In global health, inaccurate demand forecasts cost lives.

Despite the criticality of good information to demand forecasting, those currently engaged in forecasting for health products in developing world markets frequently find that the data they need are either not available or not credible. Such information limitations are clear drivers of forecast inaccuracy. The global health community is increasingly recognizing the need for concerted action to address the challenges inherent in gathering and disseminating the information required to credibly forecast demand in developing world markets.

Identifying information requirements and priorities across players and forecast types

A detailed mapping of forecast processes and numerous in-depth discussions with "core forecast developers," identified 17 "information categories" that together comprise the most critical and frequently employed inputs to forecasting demand for health products in developing world markets. These 17 categories have been carefully refined, and are broadly endorsed by Working Group members as both accurate and comprehensive. Further, initial findings around information requirements were validated via an "Information Needs, Gaps and Sources" survey distributed to various stakeholders regularly engaged in the forecasting process.

The information that suppliers, PDPs and buyers utilize for demand forecasts falls into four categories: 1) international data 2) national data 3) disease/product data, and 4) target population/behavioral data. Within these categories, there are 17 specific information elements that together capture the information used most frequently by forecast developers (described in the tables below).

The consistency of the "information wish list" provided by forecast developers, even across organizations, products, and disease areas, is a significant finding in itself. Furthermore, all players identified significant and highly consistent gaps in the availability and reliability of the majority of information currently available for use in forecasting.

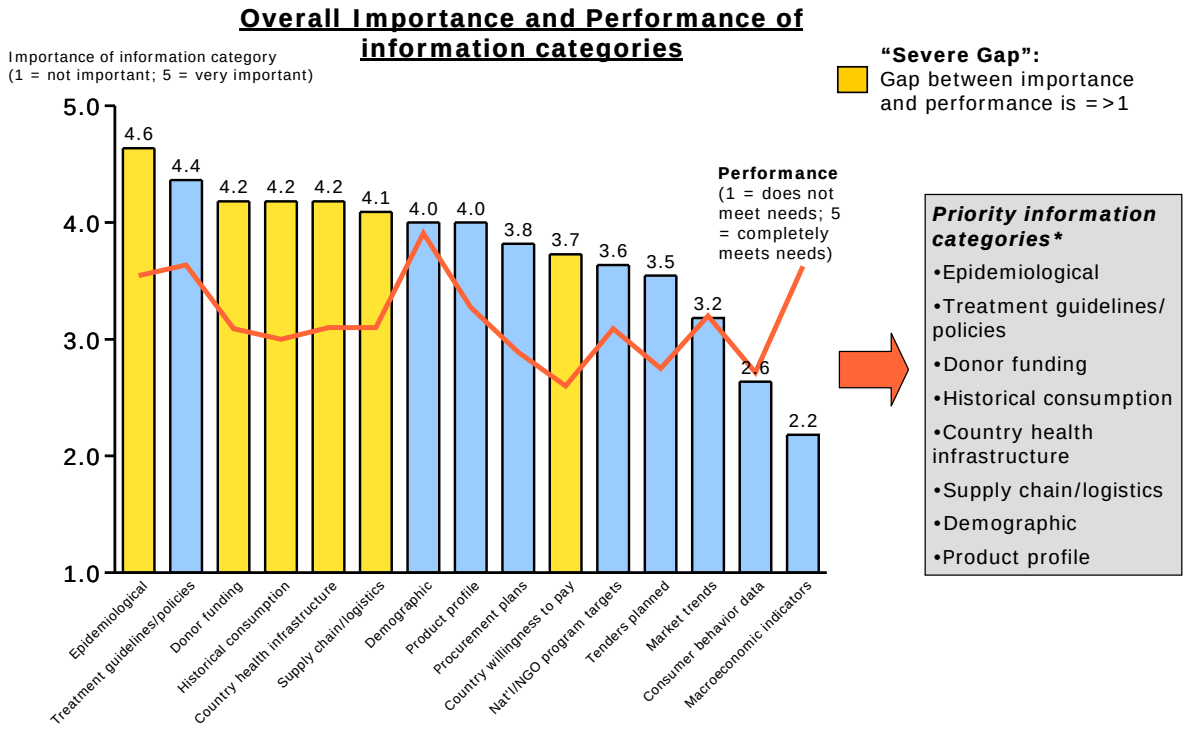
	Information Element	Description
INTERNATIONAL DATA		
1	**International Treatment Guidelines & Policies**	Information on global regulatory processes & treatment guidelines, including: • WHO pre-approval process • WHO Treatment Guidelines • WHO Essential Drugs List • Other global processes/guidelines
2	**International Donor Funding & Program Data**	Information on donor-generated resources, including: • Historical international donor funding by product by country & program • International donor funding targets & projected funding by product by country & program • Anticipated timing of funding availability • Other funding constraints
NATIONAL DATA		
3	**National Macro-economic & Socio-political Data**	Information on country wealth, growth & socio-political factors, including: • GDP growth rates • GDP per capita • Socio-political indicators (e.g. political stability, government effectiveness, regulatory quality, rule of law, control of corruption, & accountability)
4	**National Health Service Coverage Data**	Indicators of historical/present health care coverage of target population, including: • Rate of immunization • Rate of detection/diagnosis • Percent receiving treatment • Contraceptive prevalence
5	**National Health System & Accounts Data**	Indicators of the strength & capacity of the health care system (both personnel & health care facilities), including: • Public expenditures on health (including historical & projected national government spend on healthcare, programs, or specific products) • Private expenditures on health (out of pocket expenditures, pre-paid plans) • Physician/Nurse/Midwife/Dentist/Pharmacist/Health worker density • Hospital/Hospital bed/Pharmacy/Laboratory/Clinic density • Number of medical/nursing schools • Indicators on responsiveness of health system
6	**National & NGO Program Targets**	Information on the size, scope & impact of country programs, including: • Patient targets of in-country programs • Service statistics of in-country programs • Plans for expansion/scale up across in-country programs
7	**Government Willingness to Pay & Likelihood of Adoption**	Indicators of government willingness to invest in & adopt a product, including: • Market research on country willingness to make investment in product vs. other potential investments • Proxies for likelihood to adopt, including: – History of clinical trials – Adoption of other new technologies • Historical data on lags to adopt (e.g. post-licensure lag)
8	**National & NGO Guidelines & Policies**	Information on national regulatory policies & treatment guidelines, including: • National regulatory processes • National treatment guidelines (e.g. National Health Policy, National Drug Policy) • National trade & export/import regulations (e.g. minimum shelf life requirements) • Program treatment selection processes/guidelines • Program implementation protocols & monitoring of compliance
9	**Supply chain & Logistics Data**	Information on the forecasting process, supply status & delivery times for particular product types, including: • Mappings of forecasting process

		• Time/location of product receipt • Historical/current product inventory levels & location • Lead times • Mappings of procurement & distribution systems
DISEASE/PRODUCT DATA		
10	**Product Profile Data**	Information on key product characteristics for existing or future products (as relevant & available), including: • Product formulation/specifications (e.g. efficacy, duration, dosing schedule, shelf life, storage & handling requirements) • Likely target population (e.g. child vs. adolescent vs. adult vs. other) • Regulatory status • Product price • Delivery & operations costs
11	**Historical Consumption Data**	Historical market sales data, including: • Historical product sales (for existing products), segmented by product & by country • Historical product sales for analog products (as a proxy for products that have not been launched), segmented by product & by country
12	**Market Trend Analysis**	Market analysis on product trends, including: • Market growth • Market share • Anticipated introduction of competitor/substitute product(s) • Analysis of public vs. private markets
13	**Country-Level Procurement Plans**	Country/program level plans for product procurement, including: • Specific procurement plans describing anticipated quantity & timing of product procurement • Historical & outstanding tenders issued by buyers for purchase of specific products
POPULATION/BEHAVIORAL DATA		
14	**Demographic Data**	Demographic data by country, including population characteristics such as: • Age • Sex • Race/Ethnicity • Income/Socio-economic status • Fertility rates • Birth rates • Life expectancies • Height & Weight • Mortality Rates
15	**Epidemiological Data**	Disease-specific epidemiological data by country & target population(s), including estimates & projections of: • Incidence • Prevalence • Mortality • Morbidity
16	**Consumer Behavioral Data**	Information to understand consumer product preferences, cultural norms, acceptable locations & providers, including: • Household surveys • Attitudinal surveys • Social anthropological studies • Compliance with existing vaccines/drugs • Market research on consumer willingness to pay • Level of education
17	**Physician Behavioral Data**	Information to understand physician product preferences, including: • Physician willingness to prescribe/physician prescribing data • Physician knowledge level

While most respondents reported using most or all of these 17 information elements, 8 were highlighted as being of particular importance to forecast development. These are:

- Epidemiological Data
- Treatment Guidelines and Policies
- International Donor Funding Data
- Historical Consumption Data
- National Health System and Accounts Data
- Supply Chain/Logistics Data
- Demographic Data
- Product Profile Data

Even more telling is that gaps identified in information quality and availability exist across the majority of information elements, but are in fact *most* severe in high priority information categories. As highlighted in the chart above, particularly severe gaps in information availability and quality exist within data on: 1) epidemiology; 2) international donor funding; 3) historical consumption; 4) national health system and accounts; 5) supply chain/logistics; and 6) country willingness to pay.



Identifying sources, users, and specific gaps for priority information elements

Why do those forecasting demand face such severe challenges with regard to information on epidemiology, international donor funding, historical consumption, national health system and accounts, supply chain/logistics, and country willingness to pay? Several factors about the way information is currently shared are important drivers: 1) information is often shared in only ad-hoc manner; 2) there is a tendency to treat information as proprietary by default and 3) there is very little of the data standardization required to share data systematically and across multiple stakeholders.

Information Element	Sources	Users	Gaps	Implications for Information Sharing Solutions
Historical Consumption	• International buyers • National buyers • Suppliers • PDPs • Funders	• Suppliers • PDPs • International buyers • National buyers	• Multiple potential sources of historical data exist per disease, but much of the existing information is not effectively or systematically shared • Data that is shared is generally not consolidated by product & must be compiled across sources • Even for individual sources, data is largely unavailable or incomplete	• Historical consumption data is used by and sourced from, both buyers & suppliers • Suppliers would be the easiest source from which to compile information, as they are more consolidated & maintain fairly standardized records of sales
International Donor Funding	• Funders • National buyers	• Suppliers • PDPs • International buyers • National buyers	• Key users have little access to product-specific funding forecasts • A consolidated view of funding across multiple funders is often not available by disease • Lack of transparency into country procurement processes, financing & funds flow • Significant uncertainty in the reliability & timing of funding	• Efforts by funders are required to: o Provide consistent reporting across diseases & donors; o Provide relevant country & product level information; o Increase timeframe of funding commitment information
Epidemio-logical	• National government surveillance data • International agencies • Other (e.g. clinical research)	• Suppliers • PDPs • International buyers • National buyers	• Disease data for the developing world is inconsistent across sources (e.g. recent attempt to compile HIV, TB, & malaria statistics across 10-12 countries revealed inconsistencies between UN, WHO, & country data) • Need for better projections of disease evolution & patient flow over time • HIS data is often unavailable or incomplete	• National buyer investments are required in improved surveillance systems • International sources should address discrepancies in disease data
National Health System & Accounts	• National government • Program implementers, distributors • International agencies • Other	• Suppliers • PDPs • International buyers • National buyers	• According to WHO, of 192 WHO member countries, only 39 have sufficient health infrastructure information o 92 have only census data, old survey data, or no data at all • Need for more frequent country health infrastructure assessments & projections	• Existing data within international agencies, national governments & programs could be better compiled & organized • Significant long term investment needed to support additional, more frequent country health infrastructure assessments
Supply Chain/ Logistics	• National buyers • International buyers • Other (e.g. customized research)	• Suppliers • PDPs • International buyers • National buyers	• Supply chain/logistics data such as inventory quantity & location is often unavailable, as systems are not in place to manage supply chain. • Manually maintained records at the facility level makes compilation & analysis difficult • Lack of accurate data at lower levels in the supply chain	• Buyer data could be shared in a more systematic manner; • Investment also required in buyer systems to improve data reliability
Country Will-ingness to Pay & Likelihood of Adoption	• National buyers • International buyers • Funders	• Suppliers • PDPs • International buyers	• Entirely conducted through proprietary, customized research projects that are not shared • Few expert providers of research & analysis exist in the developing world health market	• Customized research will continue to play an important role • Potential opportunity to share core information across players

As this summary of the sources and users of each priority information element illustrates, closing high priority gaps will require more effective and systematic consolidation and dissemination of existing information. To this end, it is reassuring to note that there are several specific information sources which cut across multiple information categories, which could help focus information gathering efforts. However, addressing the priority information gaps will require not only better information sharing but *also* additional and explicit investments in gathering "new" information – information that is not currently collected in any formalized or ongoing manner.

Information sharing in the developing world

As the prior section demonstrates, there exists a set of readily identifiable information consistently demanded by forecast developers; information that if accurately recorded, effectively compiled, and clearly presented to forecast developers would eliminate many avoidable information-related forecasting uncertainties. Yet though the "information wish list" is clear, current efforts to gather and share such information have been unable satisfy the demands of those engaged in forecasting. Core forecast developers emphasize that certain primary data are not currently captured and therefore nonexistent for current purposes. Furthermore, many indicate that *existing* data as too often inaccessible, incomplete, or inaccurate. Data from one source are invariably inconsistent with those of another source, to the point that forecast developers have minimal confidence in their own ability to distinguish which data are reliable. The following section describes the current approaches to sharing information in developing markets, and contrasts these with the models used to share similar information in the developed world context. Comparing developed and developing world "markets" for information lends insight into the viability of new information sharing solutions in the developing world context.

In recent years resources devoted to addressing developing world health challenges have rapidly and drastically increased. Yet despite this growth in available resources and the intensity of public attention to these markets, difficulties persist in gathering accurate information about the resources, products and regulatory environments in developing markets. Such limitations are becoming increasing frustrating. Priority must be given to addressing information gaps, as they hinder not only the ability to create the accurate demand forecasts, but the ability to make the many crucial product and supply chain investments that depend on accurate demand forecasts.

In response to these uncertainties, initiatives have begun to emerge to collect and disseminate information relevant to forecasting. These initiatives are distinct from previous initiatives in that the collection and dissemination of this information is the initiative's central function or at least central to its mandate. And at the same time, existing initiatives have expanded the scope of the data that they provide, in order to better meet the expanding needs of stakeholders. Yet despite these improvements, information gaps remain. One challenge is that while these initiatives themselves may focus on forecasting demand, they typically remain within existing organizations that have much broader mandates, for which demand forecasting is a low priority.

Information sharing models from the developed world

As noted by Harvard Business School professors Ananth Raman and VC Narayanan in "Aligning Incentives in Supply Chains,"[73] inaccurate demand forecasts are a frequent challenge for numerous product supply chains across the globe. Misaligned supply chain incentives are the key cause of poor

demand forecasts, and Raman and Narayanan point out that a key root cause of such misaligned incentives is "hidden information." Thus, information sharing initiatives and organizations are a common approach to improving the ability of supply chain stakeholders to forecast demand and more effectively manage the supply chain. It is therefore not surprising that there exist a multiplicity of organizations providing market and consumption information for pharmaceutical products, and that such information resources exist in a wide variety of other developed world product and service markets.

Below is an overview of the key players involved in information sharing and gathering in developed world pharmaceutical markets, which are primarily independent private firms.

	Key players	Market characteristics	Example organizations
Information sharing	**Private firms** focused on collecting and disseminating health product data across diseases	• Few players for consumption data (1 – 3 per market), where standardized data a priority • Many private firms providing product and market info • Data sold at a fee	•IMS •NDC
	National public health entities providing free, widely available data	• Public entities set standard • Data free • Private firms offer synthesized data at a fee	•CDC •NHS
Customized information gathering and analysis	**Private firms focused on research and analysis of key market data,** including product trends and purchaser behavior. May be focused on specific industry, disease or geography	• Many players in each market • Mix of generalist market research organizations and specialized orgs focused on health products market • Analysis sold at a fee	•TNS •Datamonitor •Cambridge Pharma •BioSeeker Group •Wide range of consulting firms

Implications: What models are needed to better serve the developing world?

The market for information in the developed world is highly evolved and serves the diverse needs of players across health product markets. Can a comparable market for information exist in the developing world? Given the significant increase in resources and growth in markets for these products, the answer must be yes. But how will this be achieved? Some of the lessons from the developed world are particularly instructive.

First, in both the developing and developed world, public organizations provide key demographic and epidemiological data. However, in the developed world, this data is perceived as more robust and credible and benefits from significantly greater resources invested in its collection, validation, and dissemination. Improving the quality of data from public health entities and national censes providing this data for the *developing* world would improve the ability of forecast developers to predict demand in those markets. It should be noted, that the timeline and investment for improving such information is significant, and that as discussed below, there are other opportunities for more

rapid improvements through the use of new information sharing models for product and market data.

Several observations about the developed world models for information sharing and gathering provide particular insights about opportunities to rapidly improve the availability of information for developing world markets.

1. The most significant difference between the developing and developed world markets for health product information is the presence in the developed world of a diverse set of independent organizations dedicated to collecting a wide range of data relevant to forecasters *as their primary raison d'être*:

    - Primary market data collected by a few key, credible sources not currently operating extensively in the developing world (IMS)
    - Customized market information gathering/analysis is provided by multitude of private organizations

2. These organizations are focused exclusively on information collection and analysis and need to build reputations with their customers for the quality of their information to succeed

    - Quality and credibility of information is the result of established global networks of sources and trusted methodologies
    - Risk to the firm's reputation and future revenue helps maintain information quality

3. Finally, these organizations collect data from diverse sources and serve as a neutral and objective information collector where direct sharing of information across stakeholders might be impossible or cumbersome

    - Market data is typically collected through payment of external sources and available only for purchase
    - Customized market information is collected through primary and secondary research and available primarily for purchase

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