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POINT of VIEW
JANUARY-FEBRUARY 2014

Our Perspective on Issues Affecting Global Financial Markets

The Bubble is Not Back: Putting the US Housing Market in Perspective

The US housing market is not in a new bubble.

Large increases in national house prices—to the tune of 12% year-over-year—have the media circus claiming "the bubble is back." On a clear look, though, the housing market in 2013 is a textbook story of supply and demand. In fact, the untold story of the "housing bubble" is not one of rampant overbuilding. It is instead a story of changes in the composition of housing supply.

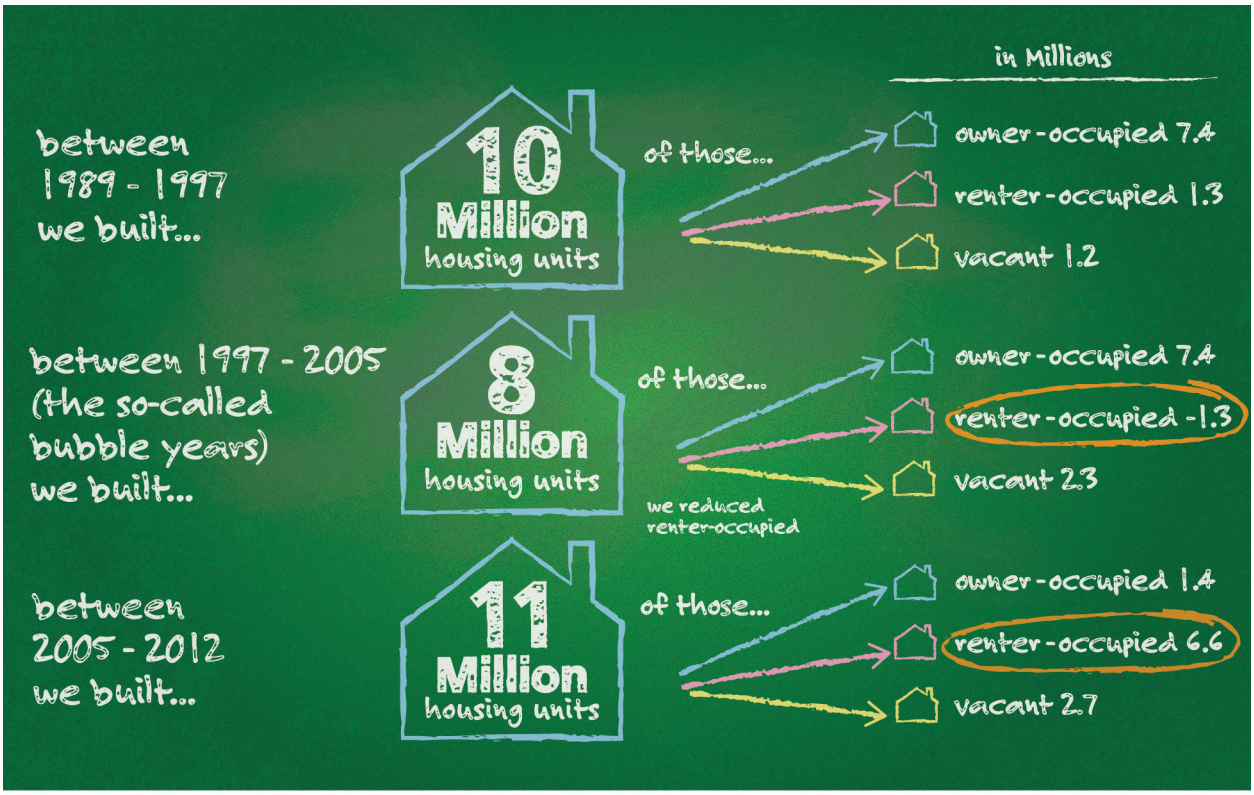
From 1997-2005, changes in the composition of the housing stock featured a notable decline in rental units and a sharp increase in owner-occupied single family dwellings. In the bust and recovery that followed (from 2006 to today), the steady work of supply and demand pushed house prices first lower and then finally higher as the housing market realigned. Given time, sellers slash prices, producers create a new mix of goods, and buyers eventually return. The combination of too few of the right kinds of housing units in a market with recovering demand should occasion rising prices and renewed construction activity.

« FROM 1989-1997 HOMEBUILDERS BUILT ROUGHLY 10 MILLION NEW HOUSING UNITS. THEN, FROM 1997 TO 2005, THE ANNUAL PEAK OF RESIDENTIAL CONSTRUCTION AS A SHARE OF GDP AND THE SO-CALLED "HOUSING BUBBLE," WE BUILT ONLY 8.3 MILLION UNITS SO HOW COULD WE HAVE A BUBBLE? »

BURSTING BUBBLES

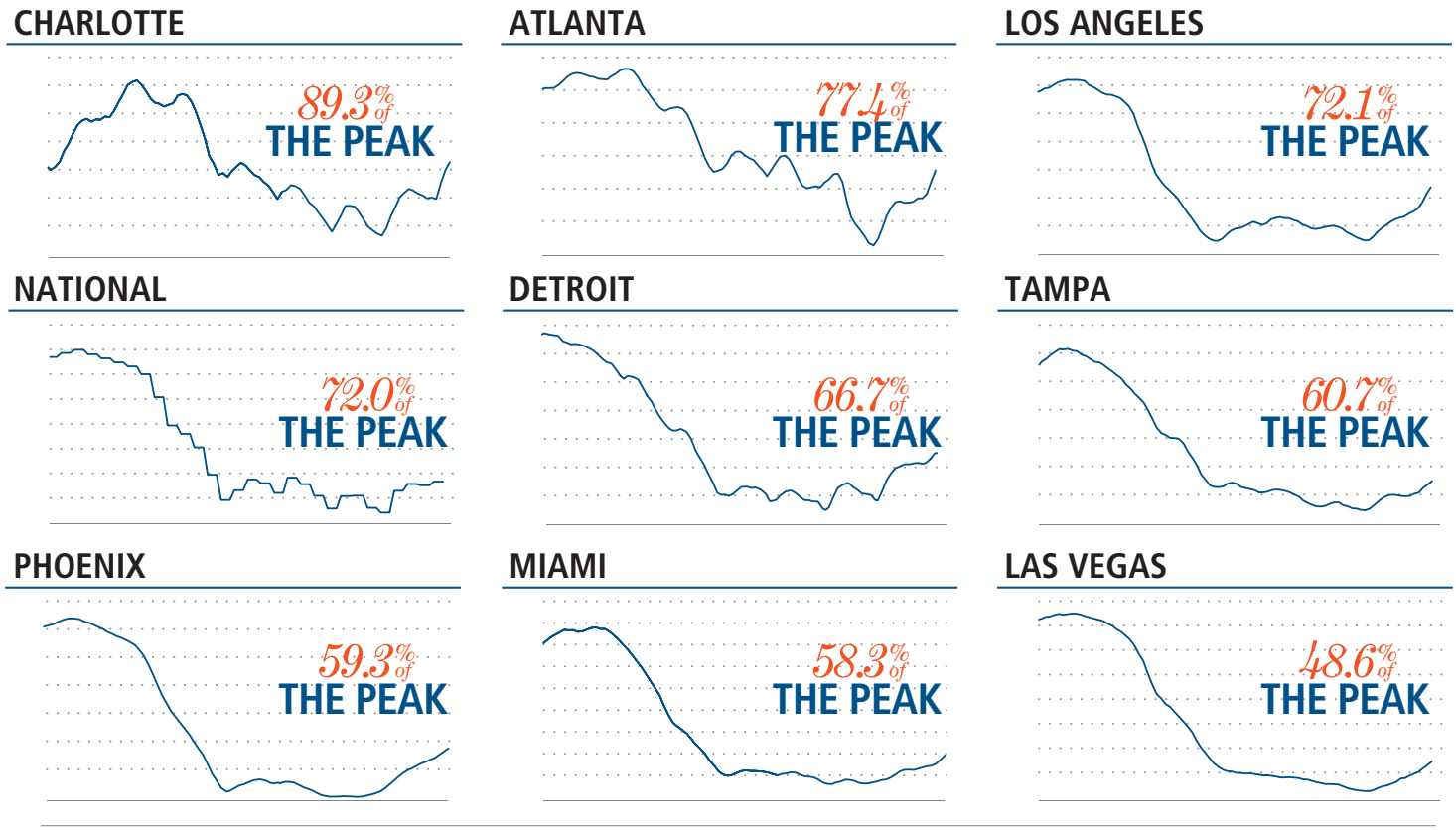
Consider the United States before the housing bubble. In 1997, approximately 115 million housing units dotted the country. This was the "housing stock." Big houses, small houses, condos and apartments, vacation homes and second homes. Some homes were vacant (12% in

fig. 1 CHANGES IN US HOUSING SUPPLY SINCE 1989



Sources: US Census Bureau and US Department of Commerce

fig. 3 HOUSE PRICE INDICES ACROSS THE NATION STILL NOWHERE NEAR PEAK* LEVELS



*Data shows S&P/Case-Shiller home price indices from January 2006 to present

Source: Standard & Poor's

1997, for instance), some were owner-occupied (58%) and the rest were occupied by renters (30%).

In fact, from 1989-1997 homebuilders built roughly 10 million new housing units. Then, from 1997 to 2005, the annual peak of residential construction as a share of GDP and the so-called "housing bubble," we built only 8.3 million units (see Figure 1). So how could we have a bubble? The answer lies with changes to the composition of housing supply.

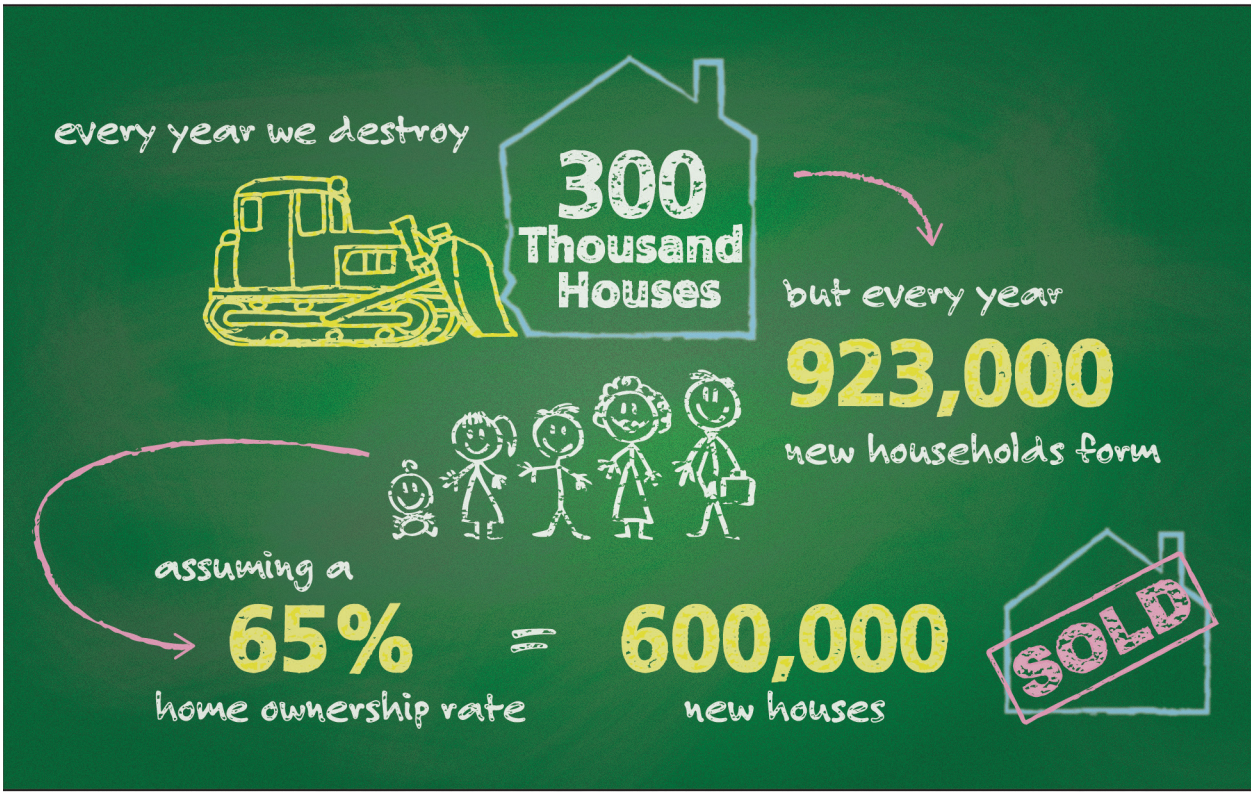
Of the 8.3 million housing units constructed during the "housing boom," 7.4 million were "owner-occupied." Meanwhile the stock of "renter-occupied" units actually *fell* by 1.4 million. No other period since 1960 witnessed a decline in the rental stock. Whether driven by euphoria or by easy credit, producers eagerly met consumer demand for owner-occupied spaces with ample supply.

Such was the frenzy, that in August 2005 BusinessWeek related the story of Mr. Thompson, "a baker, a nurse for an insurance company, and now, a successful real estate investor. On Aug. 3, he made $14,500 by flipping a house he owned for only 53 days."[1] Mr. Thompson was not alone. Everyone knew someone who had bought and sold a house for a hot multiple of the purchase price. But these bidding wars were not for rental-units: price increases occurred in specific markets (housing) for a certain kind of good (owner-occupied single family units). Rather than building new rental units, developers and contractors catered to the likes of Mr. Thompson.[2]

In short, the "housing bubble" was a classic production mismatch. We built and converted too many housing units to owner-occupied or vacant for-sale, which did not match the potential buyers/renters. We built the wrong mix of goods.

« ON THE HEELS OF TORRENTIAL BUILDING AND FANATIC BIDDING FOR OWNER-OCCUPIED UNITS, MARKET FORCES NEVER STOPPED WORKING. THE SO-CALLED RECESSION WAS REALLY REALIGNMENT. »

fig. 4 THE DYNAMICS OF HOUSING DEMAND



Sources: US Census Bureau and US Department of Commerce

SHAKING THE INVISIBLE HAND

On the heels of torrential building and fanatic bidding for owner-occupied units, market forces never stopped working. The so-called recession was really realignment. In the seven long years since house price highs, we have witnessed the invisible hand setting supply in line with demand to once again produce historically "normal" valuations.

The price action of today's housing market takes direction from a simple market fact: the mix of housing supply is off. Stuart Miller, CEO of US homebuilder Lennar Corporation declared on an earnings call in 2013, "The overriding driver of recovery in the housing market remains the underproduction of both single and multi-family product throughout the economic downturn and up to and including this year."3

What might he mean? To see, let us trace back the housing boom and bust.

After building a bubble's worth of owner-occupied homes, would-be sellers of existing homes and prospective builders found fewer buyers. With so many houses available for purchase (roughly 24 months' worth of supply) and so few willing buyers, prices fell (see Figure 2 on the previous page). At a point in early 2009, house prices had lost 19.4% year-over-year; homes that only a year before sold for $400,000 now only found buyers at $322,400.

As time passed, though, the market began to clear. Sellers reluctantly marked down their asking prices and converted former owner-occupied units into rentals, while buyers opportunistically returned to the market, scooping up existing homes at thrift store prices. Soon, buyers came to outnumber sellers.

From 2005 to 2012, developers re-jiggered their mix of supply, producing 6.6 million renter-occupied units and just 1.4 million owner-occupied units. Though it took seven years, and a long trend of falling prices, the market for buying and renting properties became attractive enough to encourage sellers to raise their prices.

THE DEMAND SIDE

Housing buyers vanished during the recession and, despite an extended period of record low mortgage rates, came back only slowly. Rapidly rising house prices have inspired fears in some of another boom-bust cycle. But

by understanding the types of purchases, the kinds of buyers, and the longer-term fundamentals driving housing demand, the latest price pressures make sense.

The first back to the market (in earnest) was the cash-buyer contingent. In early 2010 the Washington Post reported, "all-cash investors are snapping up the cheapest properties and helping clear out the excess supply of homes on the market. They're betting that the market has hit bottom or will soon."[4] Even as late as the first quarter of 2013, buyers who needed no financing accounted for as many as one-third of all purchases.[5]

To certain minds these all-cash buyers have become the bane of those wanting to purchase on credit. However, institutional buyers (who purchase 74% of homes with cash) represent only a small fraction of total purchases. Of the approximately 13.5 million single family rental homes in the United States, institutional investors only own between 100,000 and 300,000. [6]

Rather than a sign of froth or excess, these investor buyers represent a market searching for the correct mix of goods and prices, focusing on the most distressed part of the housing market (those homes damaged in the process of foreclosure), bearing risk that other buyers avoid. For the largest institutional buyers, foreclosed houses represent roughly half of their entire portfolio.[7]

« THIS WEAKNESS EXPLAINS SOME OF THE SLOW PACE OF OVERALL ECONOMIC GROWTH. CONVERSELY, THE RECENT TURN IN THE HOUSING MARKET SHOULD KEEP OPTIMISM IN THE AIR FOR THE US ECONOMY. »

Institutional buyers (hedge funds, private equity funds, etc.) have also been the largest buyers in some of the more distressed locations. As a result, despite the alleged (and often reported) manic bidding wars in "hot markets," prices have risen off of their lows but rarely exceed 60% of their bubble value (see Figure 3).

Eyes trained on the more distant horizons of the housing market also see fundamental drivers of demand elevating. At the heart of housing demand sits, well, households. Namely, new household formation and homeownership rates. Between 2006 and 2011, roughly 550,000 new households formed per year, on net, compared with 1.35 million per year over the prior five years.[8]

But we know that the US population grew by 2.4 million people in 2012. We also know that approximately 2.6 people constitute one household. Assuming that those new to the population form households, we can conservatively estimate the formation of 923,000 new households for the next year (see Figure 4).

Further, assuming 65% (the current homeownership rate) of new households formed will own their house, one can expect demand for nearly 600,000 new owner-occupied units per year. As of June, we were on pace to build about 900,000 houses this year. Also of note, we bulldoze another 300,000 or so homes per year as the housing stock ages and otherwise falls into disrepair. On net then, the current pace of building barely keeps up with new household formation. Housing suppliers recognize this structural demand driver, building new supply to match not only the number of homes these buyers want, but also the type and location.

We find further evidence of a supply mismatch in the kind of homes builders have erected in the past two years. Since the start of 2012, the pickup in housing starts on multi-family units has far outpaced historic averages. Multi-family home starts typically account for 24% of total starts: since 2012, multi-family starts have accounted for 30% of total new residential building activity. Such rapid increases in building activity for multi-family residences reflects the demand for rental properties. And given that hiring has barely kept pace with household formation, the large inventory of single-family homes built during the boom find willing buyers—for now they appear content to rent.

MARKETS WORK

Markets work to ensure excess supply clears by falling prices. Consequently, rising prices at the bottom of a bust often indicate constrained supply. But "markets" are just collections of people like you and me. And "market" adjustments take time. As Ed Leamer rightly notes, "this very slow price-discovery occurs because people celebrate investment gains, but deny losses. Owner-occupants of homes can likewise hold onto long-ago valuations and insist on prices that the market cannot support." [9]

Our most recent experience in the housing market contains broader lessons about the functioning and malfunctioning of the "macro" economy. In boom periods, the willingness of suppliers to undertake the projects which they feel will be met with most demand directs capital towards certain ends—e.g. construction workers and single-family homes. However, when the boom comes to an end the formerly money-minting developers and contractors no longer require as many carpenters, electricians and plumbers. In turn, carpenters, electricians, plumbers and mortgage brokers cut back on demand for a vast array of products and services, from restaurant visits to yoga classes. This ripple is the recession.

Bust periods in the cycle enforce necessary economic adjustments. The former construction worker who retooled or sold his house and moved elsewhere, exemplifies the dynamism of the US economy. He recognizes that prospects for employment are greater in the faster growing industries. But these adjustments take time.

As the housing market heals (and home production returns), positive knock-on effects trickle through to broad based GDP growth. In economic recoveries before the recession of 1990-1991 "residential investment" (which is how government statisticians refer to homebuilding) boosted annualized GDP growth by between 1.0-1.5%. In the quarters since the 2009 recovery officially began, residential investment added, on average, close to zero. This weakness explains some of the slow pace of overall economic growth. Conversely, the recent turn in the housing market should keep optimism in the air for the US economy.

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China's Financial System: *Does a Crisis Lurk in the Shadows?*

Economies and financial systems are a bit like rivers. Restrict and constrain them you might, but contain them you will not. Every flood season and every financial crisis the forces of these natural systems humble the talented engineers trying to set them in line with human designs.

In no other economy do we see the contest between natural market forces and human engineering more clearly than in China. In fact, much of the "mystery" about the Chinese economy—the low level of household consumption as a share of gross domestic product (GDP), the real estate bubble, the Internet videos documenting empty shopping malls and high-rise apartments, the stories about exorbitant interest rates charged by non-bank entities in the shadow banking system—arises from market forces encountering a strict and unbending institutional framework imposed by intelligent economic engineers.

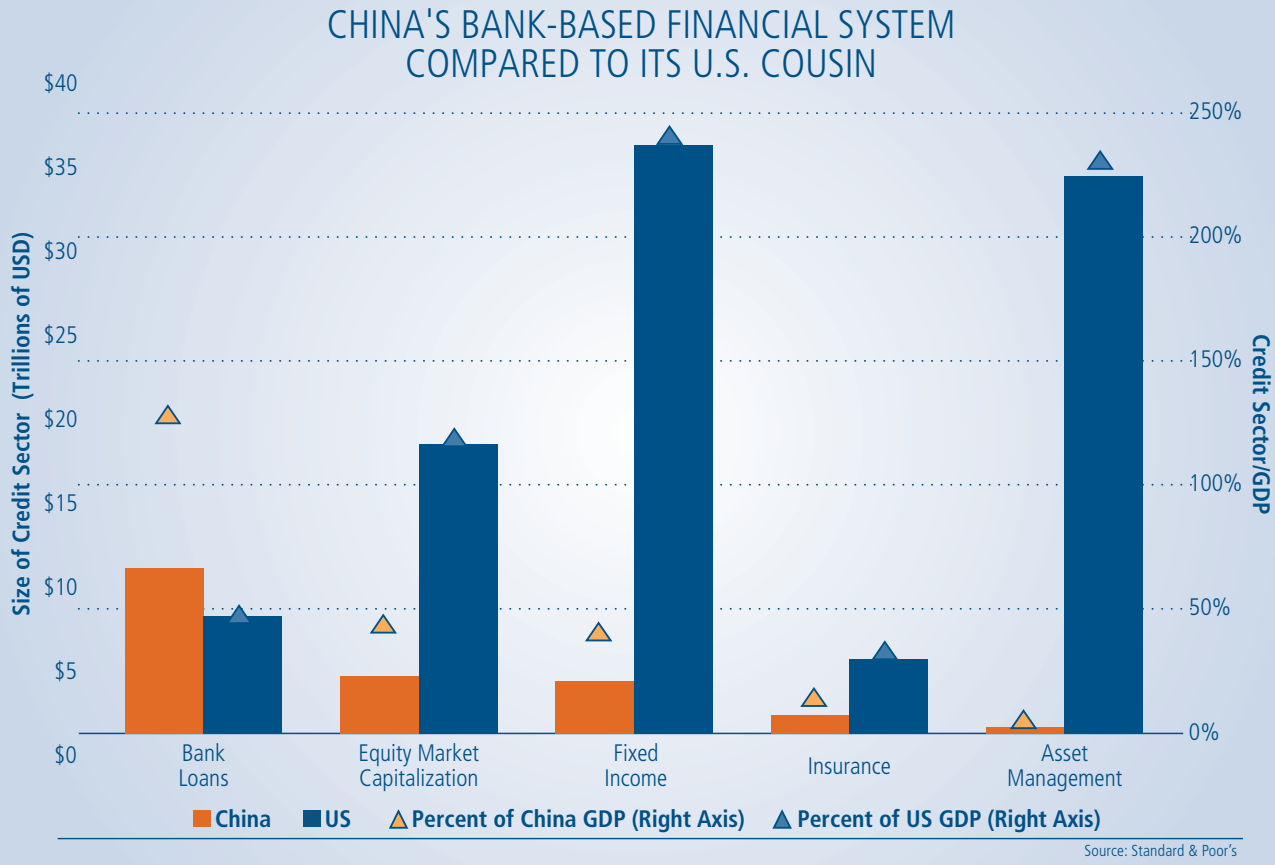
Simply shifting policies to liberalize interest rates or spark a "rebalancing" may not be as smooth as the financial markets anticipate. As with a mighty river, no matter how good and how bright the minds at work are, just because humans wish it wouldn't flood into a certain valley doesn't mean it won't.

« ECONOMIES AND FINANCIAL SYSTEMS THEMSELVES ARE A BIT LIKE RIVERS. RESTRICT AND CONSTRAIN THEM YOU MIGHT, BUT CONTAIN THEM YOU WILL NOT. »

THE MISSISSIPPI

The Mississippi River is responsible for the state of Louisiana, depositing sediment and creating landmass over

DID YOU KNOW?



Source: Standard & Poor's

thousands of years. It could not have done so by remaining in one channel. The river always took the shortest course to the ocean and if it had to switch paths to do it, then switch paths it did. But, with the development of Louisiana, the river became inconvenient—it became a threat. Human engineers attempted to corral and redirect its progress to serve human ends (they are still at work today).

Oliver Houck, professor at Tulane University, explains: "The greatest arrogance was the stealing of the sun. The second greatest arrogance is running rivers backward. The third-greatest arrogance is trying to hold the Mississippi in place. Human beings have tried to restrict the river to one course, that's where the arrogance began."[1]

The Army Corps of Engineers, like "roofers who had fixed a leak," erected the Old River Control 500 miles north of New Orleans to keep the Mississippi from diverting from its current channel to a new one down the Atchafalaya River. In their words, "We harnessed it, straightened it, regularized it, shackled it."

Why? The consequences of a naturally flowing Mississippi River were not comfortable for the world existing around it. Baton Rouge and New Orleans would be underwater if the Mississippi flowed free. By rerouting the river, commerce and industry thrive where otherwise they might not exist at all. Sound familiar?

Like the problems facing engineers in Louisiana, Chinese economic wizards must combat natural forces that do not fit comfortably with their desired ends. Liberalizing financial channels might dampen the growth of the export-focused Chinese economy. Capital seeks the highest return and those products in demand will find supply. And as policy makers try to "rebalance" the economy from export and investment–led growth to consumption, they will have to try to root out and set right all of the old means by which money and goods used to find their way. Simple interest rate liberalization is not the answer.

And this is no small task. The Chinese economy we know today is the result of market forces adapting to policies attempting to impede it: just as the water from the Mississippi flows where it pleases and redirecting it is difficult, so too with the pathways of money and goods.

THE EXCHANGE RATE REGIME

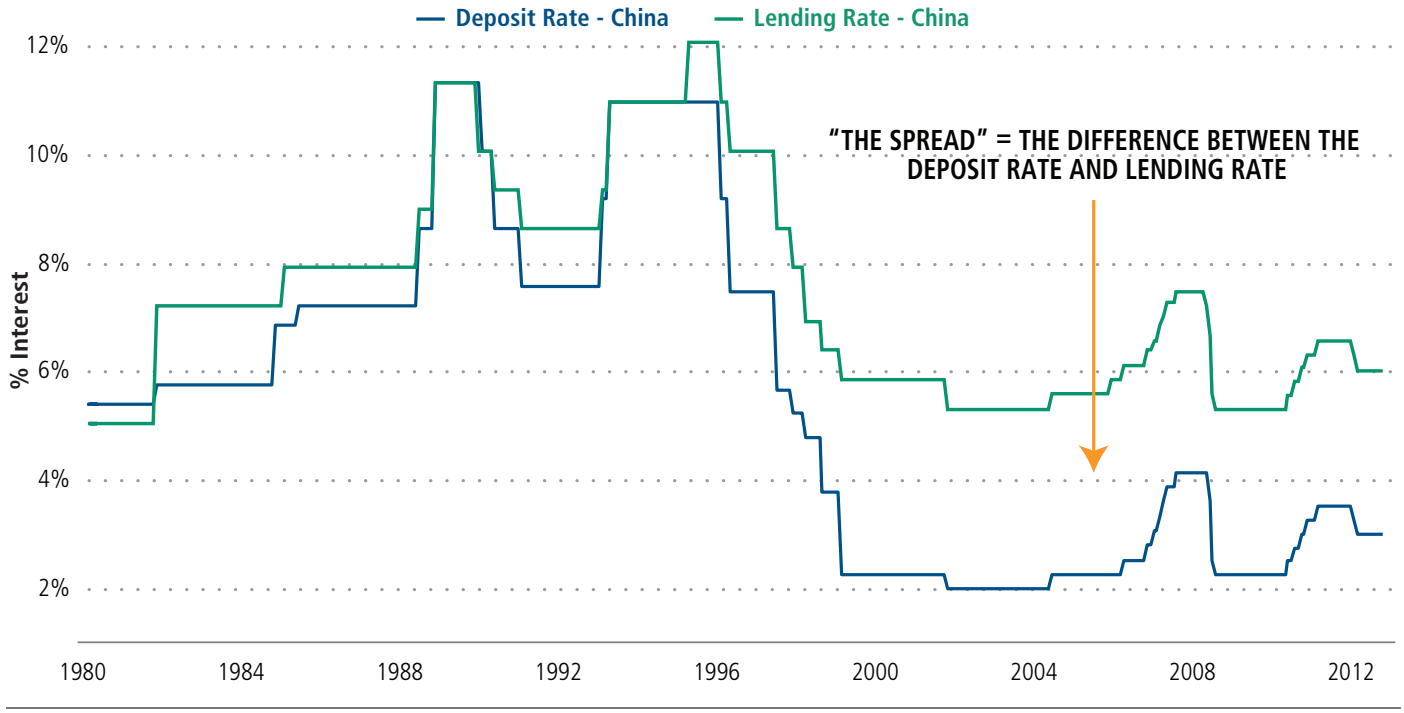
The first step in understanding the Chinese financial system is to understand its relationship to the rest of the world. This avenue is the exchange rate regime. The regime is best described as a "dollar standard." In the 19th century, countries linked their currencies to gold (hence the "gold standard" moniker). Today, some countries link their currencies not to the yellow metal but to the US dollar.

The renminbi (RMB or yuan) has been pegged to the dollar since 1994. In order to establish the "link," the central bank, the People's Bank of China (PBoC) stands ready as a "dollar-buyer-of-first-resort." That's right, the Chinese central bank stands ready to buy dollars at a stated price/exchange rate.[2]

The purpose of this is twofold: first, like gold before it, the US dollar lends credibility to the domestic currency. Having only narrowly survived a bout of hyperinflation in the 1990s, China's monetary policy record substantially improved after adopting the dollar.

« MUCH OF THE MYSTERY ABOUT THE CHINESE ECONOMY ARISES FROM MARKET FORCES ENCOUNTERING A STRICT AND UNBENDING INSTITUTIONAL FRAMEWORK IMPOSED BY INTELLIGENT ECONOMIC ENGINEERS. »

fig. 1 REGULATED "SPREAD" GUARANTEES BANK PROFITS



Source: IMF

But what if the rate differs from the market exchange rate? The evidence—in the form of accumulating dollars—will mount. Those with dollars will willingly disgorge their holdings. And that's precisely what has happened in China. In effect, to the extent that the actual exchange rate differs from the prevailing market rate, a subsidy is provided to those who accumulated dollars.

That's right: exporters. The global exchange of goods generates a steady flow of dollars. As the worldwide leader in goods exports, Chinese exporters have gained handsomely since the country's ascension to the World Trade Organization (WTO) in 2001. In 1990, China's exports accounted for 13% percent of GDP. By 2007, exports accounted for 56% of Chinese GDP—both a staggering rise and, for lack of a better word, imbalance.

In mid-2005, China modified the peg and the RMB has appreciated modestly since, rising by about 30% in real (inflation-adjusted) terms—but the accumulation of foreign exchange reserves (many in US dollars) topped $3.5 trillion. Absent the PBoC acting as a dollar-buyer-of-first resort, the situation would be different. Under a free floating exchange rate regime, current account surpluses along with booming cross-border ("foreign direct") investment over the last decade would have sent the RMB higher against the dollar much more quickly than policymakers ("the engineers") had in mind. The consequence would also have been higher interest rates and slower economic activity than we witnessed.

THE INTEREST RATE REGIME

As a direct consequence of the exchange rate regime, China's domestic financial system is flooded with liquid-

DID YOU KNOW?

The problem of an evolving system trying to provide credit is not limited to present day China. Improbable as it may seem, consumer credit in the early 20th century in the United States looked very similar. A burgeoning urban population with new found consumption preferences needed ways to pay for the new goods and services available in the marketplace. So great was the demand for credit, early consumer lenders ("loan sharks") charged annual rates of interest in excess of 1000%. How could they get away with such exorbitant charges? Such high charges exist today. Indeed, credit-starved consumers are always willing to pay later for money today.

ity. By purchasing dollars (assets) on one side of its balance sheet, the People's Bank of China creates a new liability (RMB deposits) on the side of its balance sheet. The banking system, in turn, holds these RMB deposits as "assets."

Of course, this fact is not lost on the system engineers. How to control this flood of domestic liquidity? China imposes an implicit tax on the banking system by forcing banks to hold RMB-denominated deposits ("reserves") and securities (such as central bank bills) that may offer sub-par yields. In fact, this cumbersome method for controlling liquidity means the Chinese banking systems reserve requirements are among the highest in the world at over 20% (compare to the US at 2%). This serves to "soak up" the excess liquidity and keep a lid on consumer prices.

This also explains extreme volatility experienced in the Chinese interbank market. Since the PBoC does not conduct regular open market operations like its developed world cousins to "smooth out" volatility in the overnight interest rate, the actual rate is subject to the tug and pull of liquidity. If the demand for liquidity from the banking system surges, so too does the rate of interest paid on overnight reserves.

But, to keep China's banks profitable and avoid a repeat of the 1990s "bad loans" episode, the PBoC sets a "ceiling" on deposit rates and a "floor" on lending rates (see Figure 1 on page 7). The difference between the two—called the "spread"—provides a guaranteed source of profit to the banks. Governments often employ interest rate schemes to fix banking system problems—as was evident in the US banking system from the Great Depression in the 1930s until the mid 1980s.

THE SHADOW BANKING SYSTEM

The financial press is abuzz with stories on the Chinese "shadow banking" system. What explains its recent rise?

First, households earn less than the rate of inflation on their bank deposits. The negative real interest rate is effectively a tax on household income and savings. Households must save even more than otherwise to keep up with rising prices. Alternatively, households speculate in the stock market and the residential real estate market. This explains to some extent the surge in China's A-share index in 2006-2007 and the more recent run-up in housing prices. Across China, price-to-income (the most basic gauge of housing "froth") is 10-to-1, a reflection of speculative fervor.

Second, a "market-determined" interest rate on loans is likely higher than the PBoC's administrative lending rate. In an economy growing at 7% annual rate, there is a demand for credit that exceeds that which the regulated banking system provides.

« SEEN IN THIS LIGHT, A NASCENT "SHADOW" CREDIT SYSTEM SEEMS INEVITABLE. »

There is a need for a banking system willing to provide deposit services and credit services. This is what engineers often miss: they can regulate "money," but credit is a more slippery thing.[3] Sprouting up across China are trust companies offering "wealth management products." Standard & Poor's estimates that the size of China's shadow banking industry was RMB22.9 trillion at the end of 2012, equivalent to 34% of total outstanding loans in the banking sector and 44% of the country's economic output in 2012.

For example, the wealth management products often yield around 8% per annum, compared to bank deposit rates of between 3-4%. These wealth management products offer short-term maturities (often just one month) and "shadow" financial institutions lend these funds to companies (such as home builders) at double-digit rates, compared with official lending rates of around 6%.[4]

Seen in this light, a nascent "shadow" credit system seems inevitable. First, households seek out positive real returns on their deposits. Second, fast-growing private companies—which despite the "Communist, State-controlled" Western view of China comprise 90% of the growth in activity—borrow from non-bank lenders to get access to credit, often at exorbitant rates.

What's the chief consequence of this? Private bank credit in China surged in recent years. As a share of GDP, private credit rose to 120% at the end of 2012. Like the flood waters surging near the height of levees, authorities are powerless to rein in rampant credit growth.

IMPLICATIONS FOR INVESTORS

In 1973, the Mississippi River flooded, overwhelming the greatest technological barrier men had been able to put in its way. Is this what we should expect in China? Our best bet is that nature defeats the engineers' best efforts.

The good news is that China's shadow banking sector is much smaller than its North American and European cousins. As a share of GDP, US shadow banking reached more than 100% of GDP by 2007. Also, as shown in the Did You Know? box on page 4, China's financial system is dominated by banks (compared to the US). While this may cushion the blow of any panic it is not without the economic consequences discussed in this article.

Further, despite the negative connotation, the shadow system is serving the economy by providing credit-starved sectors with access to capital.

The bad news is that in terms of shadow banking, it's probably not the size that matters. If deposit-like instruments are subject to "runs" then the risk remains even if it is smaller than comparable systems around the world.

Whether shadow or traditional, bank runs "occur when large numbers of funding providers with near-term maturities decline to renew their contracts upon expiration."[5] No matter if the short-term debt is bank deposits or repurchase (repo) agreements, if the providers of funding don't rollover their short-term debts, cascading effects can cause entire markets to seize.

Worse still, as we detailed above, the existence of "shadow" institutions is *prima facie* evidence of economic and financial market distortions. While it is impossible to say what the outcome will be, it is possible to conclude that asset prices are distorted compared to what otherwise would be if the natural forces held sway over the economy instead of the engineers.

Specifically, in terms of investment activity, as a share of GDP, China's investment spending exceeded 40% every year since 2003, peaking at 48% in 2011. The high share of investment—particularly in capital-intensive manufacturing activity—is a consequence of policies pursued. Historically, rapidly growing countries have difficulty sustaining such high levels of investment. Japan, South Korea, Thailand and Taiwan, briefly peaked at 39%, 40%, 43%, and 39% respectively. So this large portion of the Chinese economy will slow.

The key task—to keep China's GDP growing at a 7.5% annualized clip—would be to boost consumption to make up for the decline in fixed investment activity. What pace of consumption growth would be needed to offset the decline in GDP due to a slowdown in investment? On average, a 9.7% rate of consumption growth, which seems unrealistic.

The idea that consumption will replace investment also falls victim to the idea that in a multi-trillion RMB economy policymakers can substitute one large aggregate for the other. In reality, consumption depends on production activity. Shifting production away from capital-intensive manufacturing to service-sector activities will impact consumption. Shifting to a more services-oriented production base will also require time—although it will ultimately benefit China as service-sector wages are higher than manufacturing wages by about 30%.

As with the Mississippi river, much of what we see in China is a result of previous engineering decisions. We doubt a transition to a different course will be smooth regardless of how skillful policymakers may be with their efforts.

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The Rise of Information Machines

The history of the world is a story about the creation, storage, communication and interpretation of information. Where is this all headed?

100%

50%

0%

% OF WORLD'S INFORMATION CAPACITY*

THE SUCCESS OF HUMAN CIVILIZATION

is based on a trial-and-error process of problem solving.

IN 300 BCE

the sum total of information resided in a few hundred thousands books in the Library of Alexandria.

ENABLED BY A GENERATION

of smart phones and new armies of information-creating machines, today's world is information rich. With these information machines available to help us understand ourselves and the world around us in greater, richer detail, humanity is on the cusp of the next great era of unrivaled prosperity.

THE KEY INGREDIENT IN THIS PROCESS:

the creation, storage and sharing of information. Information is the cumulative tally of knowledge, recipes and how-to manuals, stored in bits and bytes.

THE END GAME

is a virtual recreation of the real world in order to analyze and improve our use of resources.

APPLICATION-SPECIFIC COMPUTERS ("INTERNET OF THINGS") GROWING **3X** AS FAST

APPLICATION-SPECIFIC = FITBIT, NEST, INTERNET CONNECTED TV, VIDEO GAME PLAYER, REFRIGERATOR WITH WIFI

»MOBILE DATA

THE FASTEST TECHNOLOGICAL ADOPTION IN ALL OF HUMAN HISTORY: MOBILE PHONES.

9/10 PEOPLE ON EARTH OWNED A MOBILE PHONE WITHIN 20 YEARS.

»MOBILE VOICE

WE MEASURE COMPUTING IN MIPS OR MILLIONS OF INSTRUCTIONS PER SECOND.

HUMAN GUIDED COMPUTERS = PCs, HANDHELD DEVICES, MAINFRAME & VIDEO GAME CONSOLES.

APPLICATION-SPECIFIC DEVICES = ELECTRONIC DEVICES, HOUSEHOLD APPLIANCES & MONITORS .

GENERAL PURPOSE COMPUTING POWER GROWING **2X** AS FAST AS STORAGE AND TELECOMMUNICATION CAPACITY.

»DIAL UP

»INTERNET

DIAL UP INTERNET SURGED ONTO THE SCENE IN **1997** AND CONTINUES TO OCCUPY AN IMPORTANT CHUNK OF TOTAL INFORMATION CAPACITY AS OF 2010 ON A GLOBAL BASIS.

In 1986, **99.7%** OF TELECOMMUNICATION INFORMATION CAPACITY ON EARTH CONSISTED OF **64 KBPS** TELEPHONE LAND LINES

»FIXED-LINE PHONE

1986 — 1989 — 1992 — 1995 — 1998 — 2001 — 2004 — 2007 — 2010

1986 THE AMOUNT OF TELECOMMUNICATION DATA ON EARTH WAS INFORMATIONALLY EQUIVALENT TO **2** NEWSPAPERS PER DAY PER PERSON

IN THE EARLY **1990s** VIDEO (IN THE FORM OF VHS TAPES) REPRESENTED **80%** OF THE WORLD'S STOCK OF INFORMATION

1998 GOOGLE WAS FOUNDED. SO BEGAN THE INDEXING OF ALL INFORMATION ON THE WEB TO MAKE IT SEARCHABLE AND INTELLIGIBLE. TODAY, GOOGLE STORES OVER **100** PETABYTES OF DATA ON ITS SERVERS

IN **2010** TELECOMMUNICATIONS CAPACITY REACHED THE INFORMATIONAL EQUIVALENT OF **20** NEWSPAPER PER PERSON PER DAY

Note:
*Measure in Optimally Compressed Bits

Sources:
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The Promise of Bioscience: Once Science Fiction, Now Reality

Imagine living until you are 150 years old. Imagine how your life would change. Your first thought might be, "Imagine the health care costs!" Your second thought might be, "Do I have enough money for retirement?"

Indeed, retirement, as it is presently thought of, would be more like a mid-life crisis than a few relaxing years on your back porch contemplating the sunset.

An impossible dream? Until recently, yes. In fact, living to age 150 would require a doubling of the average world expected life span as of 2012. But innovations in bioscience may disrupt this notion—and make it both affordable and possible to reap the benefits of drastically longer life in both the developing and developed world.

A DOUBLING HAPPENED BEFORE—CAN IT HAPPEN AGAIN?

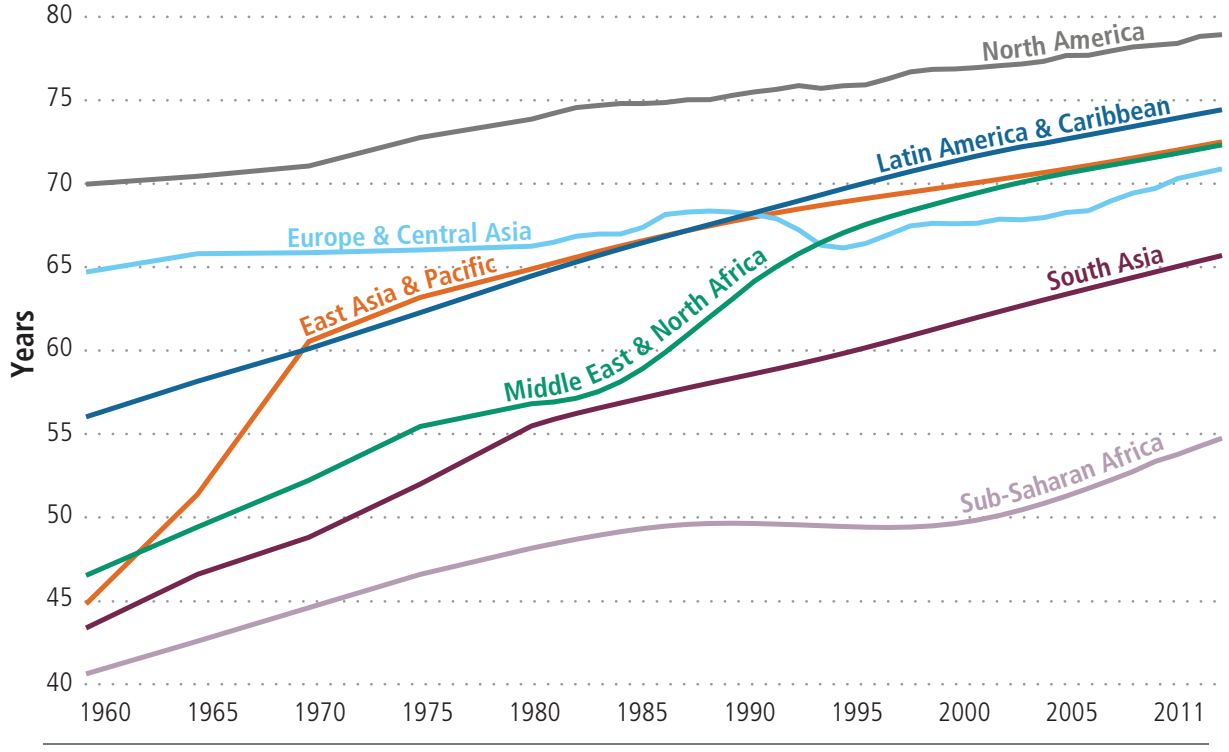
Consider the average American in 1900. Let's call him "George." George's life expectancy was 49 years. By 1950, George's life expectancy had increased by 21 years. To put this in an even broader perspective, George's life expectancy increased more in the last 60 years alone than humankind witnessed in the last 6,000 years combined.[1]

The secret formula? With an improved environment, a safer workplace, good hygiene, a better diet, access to antibiotics and an array of other drugs, and surgeries, George's lifespan today is close to 80 years.

« THERE ARE MORE MOBILE PHONES IN THE WORLD THAN TOOTHBRUSHES OR TOILETS. »

And until recently, George's chances of living to 80 were driven by his residence in the "Western world." No longer. Global life expectancy doubled since 1900, from 31 to 65 (See Figure 1).

fig. 1 WHAT CAN YOU EXPECT? LIFE EXPECTANCY BY REGION



Source: World Bank

Can we double life expectancy again? Can we reach 150?

MONITORING AND MEASURING

Once a year we trudge into our doctor for the "annual physical." Much like bringing our automobile in for a "checkup," the doctor's visit provides a mere snapshot of the health of the human body, one of nature's most complex creations. In fact, most medical testing takes place after we are already sick. This is about as useful as finding out your car needs oil after you find yourself stranded on a desolate highway.

Is that the best we can do?

It used to be. Better monitoring and measuring technology was the province of Star Trek, not of our everyday lives. But this is rapidly changing and the pace of change will accelerate over the coming decade. The first stage of bioscience is monitoring and measuring.

Enabled by a generation of smart phones, we can track ourselves better than ever before. The smartphone is a "hub," containing your GPS, calculator, watch, alarm clock, music player, photos, books. As we detail in this quarter's centerpiece (See Infographic Spread "The Rise of Information Machines"), we live in an information rich world. From the dawn of time until 2003, we accumulated just one billion gigabytes (10^9 or 1,000,000,000 bytes of data). But now we create multiple zetabytes (1 trillion gigabytes) annually. In short, there are more mobile phones in the world than toothbrushes or toilets.[2]

In fact, when Watson, IBM's supercomputer, won *Jeopardy*! in 2011, it was equipped with a 15-terabyte database to scan through, answer questions and diagnose problems. It is now being "trained" as a physician's assistant.

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Close behind this smartphone monitoring will be embedded nano sensors in our blood streams. The advantages? Constant surveillance, like a vigilant neighborhood watch, for the earliest signs of cancer, an imminent heart attack or an autoimmune attack.

Object to such intrusion on ethical grounds? Well, you are free to opt out but we think the lure of early warning will prompt many to take the plunge into this new tracking technology, monitoring and measuring weight, blood glucose, insulin, sleep quality and more.

It may sound like a flood of new devices creating information overload. It is far more than that. These devices will be connected, talking to each other and "collaborating" or sharing information. It's a global network sharing symptoms and looking for cures—without as much as a vacation break.

What does the office visit of the future look like? An ongoing, 24-hour-a-day surveillance of your body. Early disease detection, emergency early warning system. The end result: years added to the average lifespan worldwide.

REGENERATION OF TISSUE, OR PRINT ME A NEW ORGAN

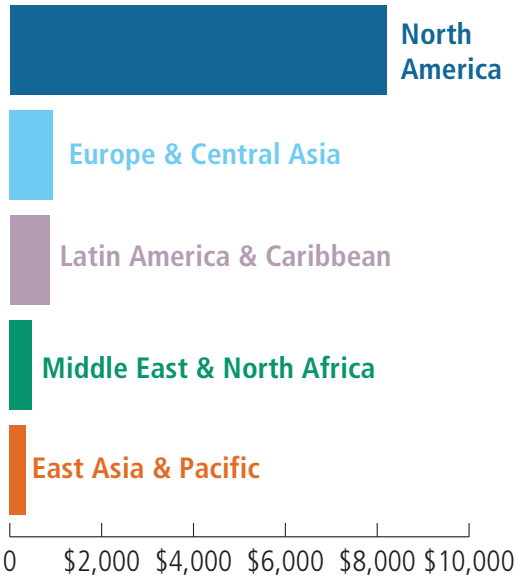
But monitoring, measuring and collaborating will take us only so far in a journey toward living to 150 years. The United Nations estimates (we take this with a huge grain of salt) that even by 2030 the average lifespan in the US will approach just 100 years, not the 150 we set out to achieve at the outset of this article. In fact, is there a biological limit to longevity?

The Methuselah tree, a bristlecone pine tree residing in Southern California, recently turned 4,843 years old, making it the oldest verified complex organism on Earth. Rockfish, clams, lobsters and jellyfish live for hundreds of years and display few signs of aging. So theoretically it seems possible.[3]

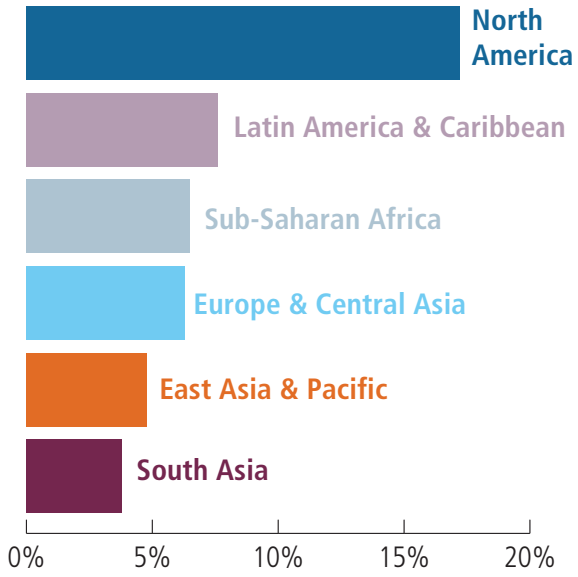
But humans already live a long time compared to most other species. In fact, chimpanzees, the longest-living primates other than humans, reach 53 years on average. Perhaps then we're already pushing the upper limits of human longevity?

That's where another step in science comes into play: replacement parts. Your organ is failing? Is your tennis elbow interfering with your game? Is your knee impeding the quality of your life? Grow new parts in a laboratory.

fig. 2 HEALTH EXPENDITURE PER CAPITA (CONSTANT 2005 INT'L $)



PRIVATE HEALTH EXPENDITURE AS A % OF COUNTRY GDP



Source: World Bank

Once again, it sounds like a science fiction series, but reality is beginning to resemble fiction. In fact, we are already doing many of these things, albeit in primitive forms. The question is how far science will take us.

Researchers at Wake Forest University in North Carolina have already grown human bladders from stem cells and transplanted the new organs into patients. More complicated organs, like hearts and livers, pose more difficult, but not insurmountable problems.

Using a device that appears to be an aftermarket inkjet printer (the printing fluid is a mix of gel and cells), researchers "print" layers of cells that form into human tissue. So far, the test subjects include hamsters but human test pilots may not be too far removed.

MERGER OF MAN AND MACHINES

Despite the promise, researchers are quick to admit that replacing a human brain—as an extreme example—could be hundreds of years away, if ever. Further, biological parts face limitations: we are frail creatures. Even with regeneration, there are limits to what can be regenerated. This potentially pushes back any living person's quest to reach 150.

Where does that leave us? Machine replacement parts instead of biological regeneration. Here's one example: a device called BrainGate. Neuroscientists made the device to create a so-called "brain-machine" interface that allows a once paralyzed person the ability to manipulate objects in the real world using only their brain activity.

« INVESTORS OFTEN WORRY ABOUT THE "AGING POPULATION IN JAPAN" OR THE "AGING POPULATION IN ITALY" IMPEDING ECONOMIC GROWTH. WELL WE HAVE NEWS FOR YOU: IT'S A GLOBAL PHENOMENON. »

In one example, a woman used a prosthetic arm to pick up a coffee container and pour back a morning cup of brew—the first time she completed this feat herself in years. Researchers expect that one day a similar device which merges human bodies with machines will allow a disabled person to walk.

How far is this away? Human beings already embrace a wide range of machines into their bodies—many we do not even think about twice anymore due to their ubiquity. Think: pacemakers, eating aids, artificial knees, and, more recently, the population of nearly 200,000 in the US hearing as the result of cochlear impact devices using computers to interpret and translate voices, our favorite

songs and other sounds into brain signals.

THE GLOBAL AGING

Lost among the science and the optimism of reaching 150 is a cold hard fact: the world is aging.

Investors often worry about the "aging population in Japan" or the "aging population in Italy" impeding economic growth. Well we have news for you: it's a global phenomenon.

That's right. The world is getting older at an unprecedented rate. Following the Baby Boom, we have witnessed a profound shift from mostly young to mostly old. The percentage of children age 5 and under has dropped from 15% in the 1960s to 7% today and falling. The number of people 65 and older has done the exact opposite, up to 15% from 5%.

Of course, twin forces drive this transformation. First, falling fertility. We make fewer babies. As recently as the 1960s, every developed country achieved the "replacement rate" of 2.1 persons required for a stable population. Today, however, every developed country is at or below that mark. In Italy and Spain, the rate is 1.4, and Germany and Japan, it is only 1.3.

And it's not just the so-called rich countries who suffer from falling fertility. The developing—or emerging rich—face fertility problems as well. All over the developing world fertility rates are on the decline.

The second force, we've already detailed above: rising life expectancy. People live longer, and this increases the relative number of elderly folks in the population. If you live in the developed world, the late 70s are the norm. And now life expectancy is 73 in China, compared to 41 in 1950. Mexicans can expect 76 years of life (compared to 51 in 1950), and Korea outpaces most of the developed world with 79 years of expected life (compared to 48 in 1950).

GLOBAL AGING PREPAREDNESS

For most of human history until the late 1900s, the "elderly"—defined as adults over the age of 60—comprised no more than 4-5% of any country. In the developed countries today, they comprise 22%. Three decades from now in 2040, the share might reach 31%. On average. In Japan and the fastest-aging European countries, it will approach or exceed 40%.

The developing world, while relatively young, is aging as well. By 2040, Brazil and Mexico will be nearly as old as the United States while China will be older. Poland will be older than France and the UK, while Korea rank with Germany, Italy, and Japan for the title of "oldest country on the planet."

As a society, are we prepared? (See Figure 2)

Aging populations drive healthcare costs. Health care costs in the US reached 17% of GDP from 5% in 1960, costing $8,000 per American per year. Globally, this figure is $1,000 and rising. Three-fourths of this spending goes to "long-term care"—the code name for diseases and conditions that very few people suffered from just a century ago, like heart disease, bad joints, Alzheimer's and other "maladies of getting old."

Faced with this "problem," countries have already begun to slash public benefits: European nations have revised the benefit structure of their public pension systems to force deep reductions in future benefits. Many countries are raising the retirement ages, and closing loopholes of early retirement with full benefits.

But is it inevitable that the costs of health care continue to rise, bankrupting governments and squeezing retirees?

The path to longevity is through technology. Yet longevity, admittedly, creates private and public costs. But the solution rests in the same place: the promise of bioscience. This is the only way out of the trap.

Let us ask another question phrased differently: is the chief problem plaguing humanity the fact that people are living too long? No, in fact, it is at least one of our greatest accomplishments.

And finally, you're all invited to our 150th birthday party. Location: to be determined. But, save the date.

SOURCES

1 David Ewing Duncan. "When I'm 164: The New Science of Radical Life Extension, And What Happens If It Succeeds." TED Books, 2012.

2 Eric Topol. "The Creative Destruction of Medicine: How The Digital Revolution Will Create Better Health." New York: Basic Books, 2012.

3 Mark Stevenson. "An Optimist's Guide to the Future: One Curious Man Sets Out To Answer 'What's Next?'" New York: Avery, 2011.

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