

Robots, Demographics, and the Labour Markets

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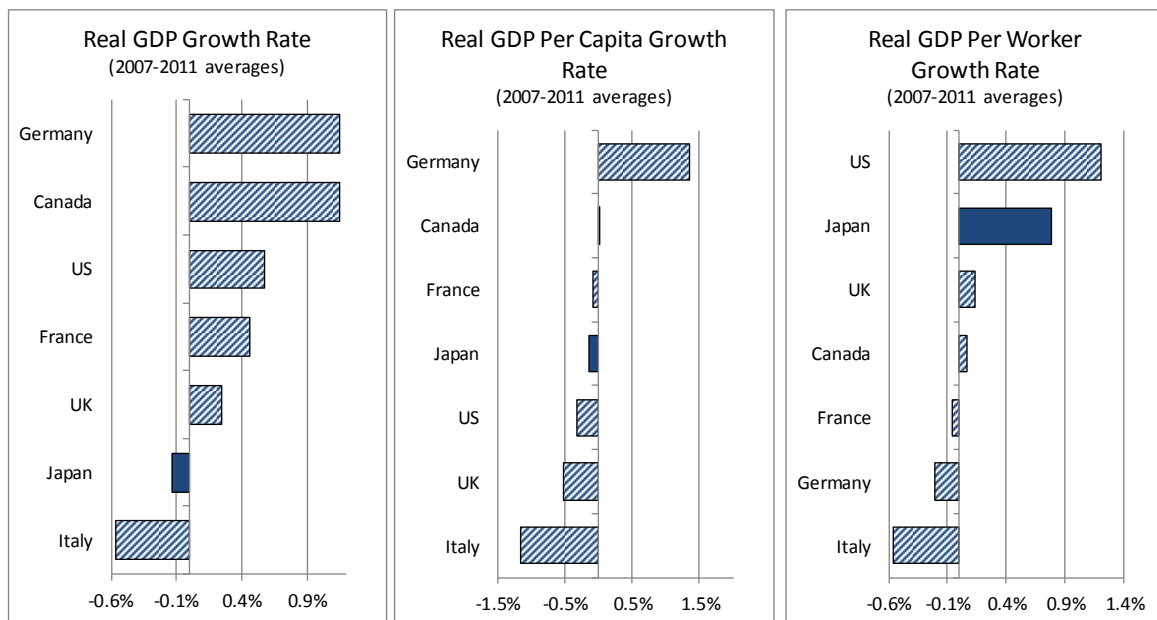
July 30, 2012

Bottom line: The exponential increase in computing power and the commensurate fall in computing costs have macro consequences. Capital and labour could be either complements or substitutes. As machines become increasingly intelligent, at a rate faster than the speed at which the labour force could re-orient itself, machines could turn from labour complements to labour substitutes. Specifically, while the Industrial Revolution replaced manual labour with machines, 'smart machines' today can think for themselves and therefore are fundamentally different. We call these self-thinking machines 'robots', regardless of whether they take human physical forms. There are many implications for the labour market. First, from a long-term perspective, developed countries that face a declining and aging population may celebrate and capitalize on the labour-substituting characteristics of robots or intelligent machines, as Japan has. This would be a good thing. Second, these intelligent machines may be advancing at a pace that is too rapid for typical labour forces to adjust to. This theory may help explain the weak demand for certain types of labour in the US right now, and the yawning gap between the capitalists and the labourers. In other words, the weak US labour market may not be due only to weak aggregate demand, competition from cheap labour in EM, or a general lack of education.

Investors and policy makers have been in a crisis-fighting mode for much of the past two-and-a-half years in Europe, the US, and most recently in China. Currently, there is intense market focus on whether the ECB is about to make a sharp policy shift toward more activism, and whether the Fed will launch QE3. Most of these economic issues seem both important and urgent. However, there are several long-term issues that are important though not urgent, but also require a great deal of attention from investors. (Incidentally, it may be useful to group events and issues into four categories, along (i) the importance and (ii)

the urgency of the issues in question. For example, Spain is both important and urgent. China’s slowdown is important but perhaps not as urgent. Getting our first coffee of the morning is urgent but not important.) It is important, in our view, to keep an eye on these non-urgent themes, and avoid being stuck in a fire-fighting mindset that might distract us from being on top of other important long-term issues.

Productivity growth and demographics are two such themes that are very important but not very urgent. The focus of our note is to take a first look at the issue of *robotics* – a special type of technology - and how they could influence productivity growth and demographics. The aim of this note is not to draw specific policy conclusions, but only to present some random thoughts on this important subject.



Source: Datastream and SLJ Macro Partners LLP

To motivate the discussion, we start with Japan. The chart on the left above shows that, during the period 2007-2011, Japan’s real GDP growth averaged around -0.1%, compared with 1.1% in Germany and Canada. Among the G7 countries, only Italy grew slower. Japan being a slow-growing economy is well-known. However, what is perhaps less widely appreciated is that, in per capita terms, Japan’s economic growth has not been that bad (the middle chart). Population growth is of course a critical factor for overall GDP growth, and one factor that may distort our views on the health of countries, abstracting from demographics. Further, if a population not only shrinks but also ages, its work

force could shrink at a faster pace than its population, thus imparting another distortion to GDP. The chart on the right shows that, measured in terms of output growth per worker, Japan ranks very high among the G7 and the OECD countries.¹

These charts suggest two things about Japan. First, the unfriendly demographic trend in Japan has been a major headwind for the Japanese economy, and will almost certainly remain one for the foreseeable future. Second, perhaps contrary to popular presumption, Japan has actually been a very productive economy, measured by output per worker.

Robotics. Robotics are a special type of ‘technology.’ The key distinguishing feature of robotics from mere machines is that *robots are able to think*. The cost of computing has been declining exponentially, and computing power has commensurately risen exponentially. This has made robotics an increasingly important type of technology to consider not only for individual manufacturing entities but also macroeconomic analysis. Here are some tid-bits on robotics.

- Robots are being increasingly used in US hospitals to carry out simple tasks such as carrying a load of laundry or moving a tray of medicines down hospital corridors. Some robots can even be remotely controlled by doctors who are not present to check on the charts and vital indicators of patients.

¹ We make several other observations about these charts. First, Italy ranks last on all three measures. Second, Germany ranks number 1 on the first two measures. We suspect the reason why it ranks low on the third measure is because of its policy of not firing workers during downturns, through work share programs. Third, in terms of output growth per worker, the US has been the most productive G7 country. This may be related to the concept of ‘zero marginal productivity’ workers proposed by Prof. Tyler Cowen: *‘The fact that the US has pre-crisis levels of output with fewer workers raises doubts as to whether those additional workers were producing very much in the first place. If a business owner fires 10 people and a year later output is almost back to normal, it’s pretty hard to make the argument that they were doing much in the first place... The story runs as follows. Before the financial crash, there were lots of not-so-useful workers holding not-so-useful jobs. Employers didn’t so much bother to figure out who they were. Demand was high and revenue was booming, so rooting out the less productive workers would have involved a lot of time and trouble – plus it would have involved some morale costs with the more productive workers, who don’t like being measured and spied on. So firms simply let the problem lie. Then came the 2008 recession, and it was no longer possible to keep so many people on payroll. A lot of businesses were then forced to face the music: Bosses had to make tough calls about who could be let go and who was worth saving. (Note that unemployment is low for workers with a college degree, only 5 percent compared with 16 percent for less educated workers with no high school degree. This is consistent with the reality that less-productive individuals, who tend to have less education, have been laid off.) In essence, we have seen the rise of a large class of ‘zero marginal product workers’, to coin a term. Their productivity may not be literally zero, but it is lower than the cost of training, employing, and insuring them. That is why labor is hurting but capital is doing fine; dumping these employees is tough for the workers themselves – and arguably bad for society at large – but it simply doesn’t damage profits much. It’s a cold, hard reality, and one that we will have to deal with, one way or another.’*

- Robots are being introduced in the US military. We are familiar with drones. But the US Military is developing robots for reconnaissance, bomb-defusal, and assisting attacks. The advantages of using robots in hostile environments are clear.
- The use of robots has had the longest history in the automobiles industry. However, installation of robots in non-automotive industries is on the rise.
- Roughly speaking, half of all the robots in the world are in Asia (Japan being the world's largest user of robots, accounting for 30% of the world's robots). Europe and North America account for, respectively, 32% and 16% of all robots.²

Demographic trends. The world faces some powerful demographic headwinds. We remind ourselves of some key demographic trends.

First, the world's population growth will likely remain positive until 2025-2030. However, population growth will vary widely across different parts of the world. Total world population is expected to reach 9.1 billion, from the current 6.0 billion or so, but all of the increase is expected to come from less developed countries. Much of the developed world will likely see a contraction in population during this period. The US is the exception. Asia's population will grow, particularly to its west but slow to its east. In Europe, population growth will be low, particularly to its east.

Second, the world's population will gradually age, with different countries aging at different rates. Total fertility for the world is expected to decline to 1.85 per woman, but life expectancy is expected to rise. The decline in the fertility rate has been a powerful trend in the last fifty years, in both developed and less-developed countries. On life expectancy, the UN believes the life expectancy of developed world could rise to 97 by 2100. The net result of a lower fertility rate and a higher life expectancy is an aging population, and, therefore, a shrinking labour force, as a percent of total population. Already, in developed countries, the elderly population (60+) is already larger than the 12-24 age group.³ For the less-developed countries, this cross-over point is expected to be reached by around 2040 – a short generation from now.

² Chijindu and Inyijama, (2012) 'Social Implications of Robots – An Overview', International Journal of Physical Sciences Vol 7(8): 1270-1275.

³ The ratio of the elderly to the 20-65 age group (the work force) is usually referred to as the 'dependency ratio.'

Currently, only 11 countries have a median age above 40 years. However, by 2050, 89 countries are expected to have their median age above 40 years.

Robotics + demographics: Japan's experience. Most countries face the constant challenge of generating productivity growth to produce economic prosperity. At the same time, most developed countries will also need to deal with the powerful headwind of hostile demographic trends. The statistics on Japan shown above suggest that, in the case of Japan, actively adopting technology may not be sufficient to fully overcome the effects of demographics, but could go a long way in reducing these negative effects. It is crucial that Europe put out the fires in Spain and Italy now. However, Italy has one of the most hostile demographic profiles around. Fertility rate of 2.1 is what is required to keep a population stable, *ceteris paribus*. Italy's fertility rate is only 1.3 – among the lowest in the world, similar to that of Japan. Spain's fertility rate is, at 1.4, not much higher. This compares with 2.1 for the US and 1.9 for the UK. It has been calculated (by demographer Peter McDonald) that, at this pace, Italy's population may decline by 86% by the end of the century: from 56 million currently to 8 million. In short, putting out the financial fire is urgent, but the demographic trend in Western Europe is perhaps an even more important issue to deal with, even though it is not as urgent.

With its terrible demographic trends and a social aversion toward immigration, Japan has embraced robots and actively developing robotic technology to help it deal with these demographic headwinds as well as the fallout from its financial crisis two decades ago.⁴ Its experience with robotics is worth examining. For Japan, immigration is not a socially preferred policy reaction. Encouraging greater female participation in the labour force is in theory another option. However, that could perversely further depress the birthrate. Yet another option would be to employ elderly workers. But these workers aren't able to do manual labour or tend not to have the technical capacity to deal with the changing technology and skillset required.

Following WWII, Japan experienced a brief baby boom from 1947 to 1949, which was followed by a baby bust. Japan's birth rate decline from 4.5% in the late-1940s to 2.0 by 1957, and further to around 1.3 since 2003.⁵ Its population

⁴ According to Mori and Scarce, (2010) 'Robot Nation: Robots and the Declining Japanese Population,' the first robot in human form was created in Japan in 1928. By the 1980s, roughly 50% of the world's robots were used in Japan.

⁵ Mori and Scarce (2010).

declined for the first time in 2005. At present, around a quarter of Japan's population is over the age of 65. (For comparison, the figures are 14% for the US and 5% for India.) It is expected that this figure for Japan could rise to 32% by 2030 and 40% by 2050.

Keeping the population stable is of course the first-best solution to Japan's demographic problems. However, until Japan can raise its fertility rate, it will need to look for other solutions. Labour-substituting technologies, such as robots, will continue to be developed and commercialized.

Other macroeconomic effects. There are some additional macro issues to consider, related to the use of robots or highly-intelligent machines.

- **A complement of or a substitute for labour?** As mentioned above, technology can be used to enhance labour, i.e., some types of technology could be complements to labour. However, other types of technology could be used to replace labour, i.e., technology could be substitutes for labour. Countries face different challenges in regards to employment. Some countries (like Japan and most developed countries in the years ahead) suffer from a structural labour shortage, and machines that substitute for labour are needed. Other countries (like China and the US now) need employment growth to absorb the excess supply of workers. This raises the important question whether technology enhances employment or it steals jobs from us. Last year, President Obama attracted criticisms when he blamed technology for job losses: *'(T)here are some structural issues with our economy where a lot of businesses have learned to become much more efficient with a lot fewer workers... You see it when you go to a bank and you use an ATM, you don't go to a bank teller, or you go to the airport and you're using a kiosk instead of checking in at the gate.'* The fact is that ATM's have not displaced bank tellers: at the introduction of ATMs in 1985, the US had 60,000 ATMs and 485,000 bank tellers. In 2002, the US had 352,000 ATMS and 527,000 bank tellers.⁶ The world has experienced great technological improvements in the last century. Yet we have always managed to create new and different jobs. Having said this, what is new is the possibility that technological advances may be progressing at a rate that is 'too fast' relative to the speed at which the world's labour force could adjust, and

⁶ The Economist, 'Technology and Unemployment: Are ATMs Stealing Jobs?' June 2011.

machines (e.g., robots that could think) that are so smart that they replace workers, or the machines are becoming smarter at a pace too fast for the work force to be retrained for new jobs.⁷ Researchers from MIT have also warned that computers and robots will replace humans in enough jobs that they will dramatically change the economy. Associate Director of the MIT Center for Digital Business Andrew McAfee said, ‘*What we’re finally seeing is that our digital helpers aren’t just catching up to us, but, in some cases, are passing us.*’⁸ Our point is that computing power may have fundamentally altered how capital interacts with labour. The high spending on capital expenditures (i.e., technology) but low hiring in the US in the past two years is consistent with this view that companies are replacing certain types of labour with technology.

- **A ‘vanishing middle’?** This was the title of an article in the *Economist* on the same subject, making the proposition that intelligent machines (what we call ‘robots’) may be replacing middle-skill employment: ‘*Many middle-skill positions – like factory line worker or back office clerk – are of the routine sort that can easily be either offshored or replaced by robot or computer programme. At either end of the skill spectrum, however, are a range of non-routine tasks – like design (at the high-skill end) or janitorial (low-skill) work. Employment opportunities for these positions have risen.*’⁹ This idea – a point we share – came from another MIT economist David Autor, who said, ‘*Low-skilled and low-paying jobs, such as dog groomers, restaurant wait staff and barbers, should be safe. Those are jobs that would be tough for computers or robots take on... High-skilled, high-paying jobs, such as high-technology workers and healthcare providers, should also be safe.*’ Thus, while technology should enhance the wealth and prosperity of the overall economy, its distributional impact on different parts of the labour force may be different.¹⁰ Specifically, contrary to popular presumption, low-

⁷ Also see Robin Hanson, ‘Economic Growth Given Machine Intelligence.’

⁸ Erik Brynjolfsson and Andrew McAfee, (2011) *The Digital Frontier*.

⁹ Some have even suggested that some high-skilled jobs may also be in jeopardy. One of the founding engineers at Skype – Jann Tallinn – has made the point that machines are becoming smarter than we are. Cheap computing power has allowed machine to beat humans at chess, be better at voice and face recognition, and be superior at trading on the stock market. He said, ‘*(M)y core message is actually that this thing is not science fiction, this thing is not apocalyptic religion – this thing is something that needs serious consideration... Once computers can program they basically take over technological progress because already today the majority of technological progress is run by software, by programming.*’

¹⁰ In Sjöholm and Lundin (2010) ‘Will Science and Technology Solve China’s Unemployment Problem?’, *Asian Economic Papers* 9:2, it was argued that, based on industry level data from China, extra spending on science and technology has not led to an unambiguously positive effect on employment.

skill workers in the services industry might be better sheltered from competition from robots. Since high-skilled work (art painting, law practice, or economic analysis) is relatively expensive for robots to replicate, this leaves middle-skill workers most vulnerable. Prof Autor has evidence supporting this thesis.

- **The rise of EM.** Robots are becoming cheaper to build and run. In Japan, there are anecdotal reports that some manufacturing activities are no longer out-sourced to developing countries because robots can do certain tasks cheaper. In general, as the cost of robotics fall, and their use become more prevalent, out-sourcing to take advantage of cheap labour costs elsewhere might decline. Developing countries can continue to rise, but will need to increasingly rely on their own indigenous demand rather than exports or out-sourcing, when cheap robots become their competitors.
- **Income distribution.** There is an interesting McKinsey report written by W. Brian Authur – ‘The Second Economy’ – that makes the point that there is a large and growing ‘tech economy’ that runs parallel to the physical economy we deal with. A growing part of our activities (e.g, the computers that do all the work related to us checking in on a flight or how a shipment is tracked and processed through a port) is now being done by a virtual system that is constantly running. It is a neural system for the physical economy. Some of this technology is job-creating, but some is job-destroying. But this technology should be profit-enhancing for corporations or the ‘capitalists’. As technological advances accelerate and the use of robots or smart technology becomes more prevalent, the divide between capitalists and labourers and between different types of workers should yawn.

Bottom line. Recent advances in computing technology, both hardware and software, have exponentially increased the computing power of devices and reduced the cost of computation to such a point that many machines are now ‘smart’ enough to think on their own and carry out a wide array of tasks to be a substitute for labour. The prospect of some of this technology (robotics) countering the hostile demographic headwinds in aging countries like Japan is encouraging and welcome. However, while job-substitution may be good for an aging society that has a labour shortage (like Japan now and Italy in the coming years), it is not good for an economy that needs to generate employment (like the US and China). Economies being increasingly run by machines and robots

may not be a new idea: most of us have seen Star Wars, the Terminator, and Wall-E. However, what used to be a futuristic idea may already be a relevant factor now, in helping to explain why the US is struggling to generate jobs and why Japan's productivity growth is so high.

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