

## Technology advancement and Inequality

To predict the future trend of inequality under technology advancement in China, I first model the historical relationship between the inequality and technology and then analyze the variations and constraints in the model by comparing Denmark, South Korea, and China. I argue that online coding education (OCE) technology has great potentials to reduce China's education inequality and income inequality in a short run because it's both encouraged by the AI policies in China right now and open for NGOs and private sectors to come in reducing social inequality and adapting to labor market needs. The technology itself is scalable to reach the particular depth of population and width of geographic coverage in China, but its long term effect on inequality is subjected to the changing political dynamics.

### HISTORICAL TREND BETWEEN INEQUALITY AND TECHNOLOGY

Agricultural revolution and industrial revolution are the biggest two eras of technological advancement in human history. Focusing on examining the inequality before and after these two events that impact human productivity across all societies allows us to see the regularities in historical trend on a coarse-grained level.

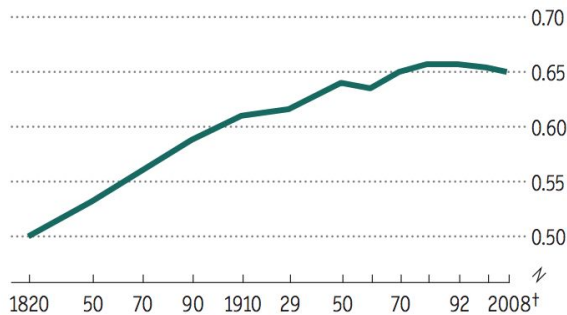
Many archeology evidence found that hunter-gatherer society before agricultural revolution mostly maintained an egalitarian social structure (Harari, 2015). Wealth and property is not a concept in people's mind, until agricultural revolution. What agriculture enables is the storage of food which is not possible when the tribes don't settle down. Then comes the invention of ownership and hierarchical social structure which is the origin of inequality. Since the industrial revolution, inequality has been rising both among and within countries across the world (see Figure 1) (*For Richer, For Poorer*, 2012). England, the starting place of revolution had its Gini coefficient shot up from 0.4 in 1823 to 0.63 in 1871 as its entire economic structure shifts from labor-intensive to energy-intensive with the inventions such as steam engines<sup>1</sup> (The economy, n.d.). Karl Marx summarized the essence of capitalism dynamics with technology as the conflict between the material productive forces of society (e.x. technology) and the existing relations of production (e.x. Ownership of wealth; capitalism) (Claeys, 1984). When one overwhelms the other, a new form of production material or production relation need to emerge

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<sup>1</sup> For example, mill workers who can work with machines, now aided with machinery inventions, are more productive than rural farming workers. The difference of productivity is quickly reflected in wages, not to mention capitalists who reaped the benefits from building infrastructure and gaining bargaining power in the process of new forms of production and relationship with labors.

to resolve the conflicts.<sup>2</sup> Under such theory, inequality is just one type of outcome depending on the new production relations formed.

Global inequality, Gini coefficient\*



(Figure 1: global inequality has been rising since industrial revolution, providing coarse-grained support for the linear relationship between technological advancement and inequality)

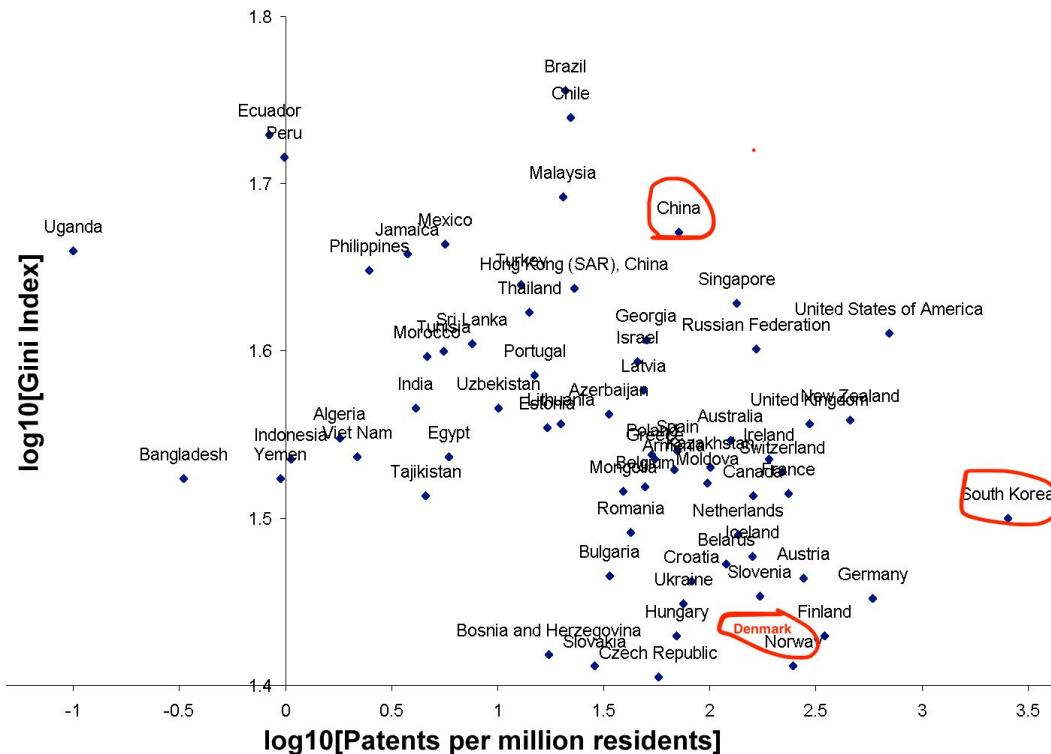
## INSTITUTIONS AND GOVERNMENT POLICY CREATE VARIATIONS

With both empirical evidence and theoretical supports, I am confident to say that inequality does rise, on a coarse-grained level, with technology advancement, if little human interventions come into play. However, taking a slice of the current mapping of income inequality and patents per million residents, (see Figure 2) (*Do more equal societies produce more patents? Some very preliminary data, 2010*) we can see drastic variations among many different countries<sup>3</sup>. I decided to compare Denmark (Gini: 0.25), South Korea (Gini: 0.3) and China (Gini: 46.5) to illuminate how different countries' institutional interventions, political environment, and policies to counter or reinforce inequality in their own cases<sup>4</sup>.

<sup>2</sup> For example, the Core book reasons that England were the first to adopt industrial revolution because 1) the energy price is much cheaper compared with high human wages, 2) it reached the edge of diminishing productivity per capita (Malthusian trap) and 3) the accumulation of wealth and capitals cannot turn into productivity due the constraints above, which creates perfect environment for machine inventions. Therefore, machinery inventions emerged to free up unused capitals and energy, to enable a bigger "pie" while at the same time allows a reshuffling of production relations so that people who own production materials, such as factory owners in 18th century England, were able to chunk off a bigger portion which results in widening inequality as part of the dynamics.

<sup>3</sup> There are many caveats at interpreting this graph. 1) Denmark is not on the graph originally since it's too small. I manually indicate it based on another graph produced by the same source that focuses on Europe. 2) The measurement is another "classic" per capita indicator, which means it may not be fair to

<sup>4</sup> Denmark is chosen because it's famous for wealth redistribution and has very different social, economic system than China and South Korea. South Korea is chosen because it shares similar development path and culture with China.



(Figure 2: Huge variations between number of patents, as a coarse-grained indicator for technology advancement, and inequality among countries).

### Denmark - the Labor Union and State Redistribution

Denmark is famous for being a high social welfare state with steady economic growth in the past decades. With similar GDP per capita to U.S., Denmark managed to maintain a Gini coefficient of 0.25 and its top 1% income share of total economy is only about 5%. The secret sauce behind such success comes from three pillars of its economy: 1) wealth redistribution through progressive tax and transfer policy, 2) active labor market policy and 3) blanket social protection policy. With redistribution intervention, Denmark's gini index managed to shrink from 0.44 to 0.25, which is a dramatic extent compared with other countries in world (such as Korea which only shrinks 0.01) (See Figure 3) (*Income Inequality*, n.d.).

## Inequality of incomes before and after redistribution

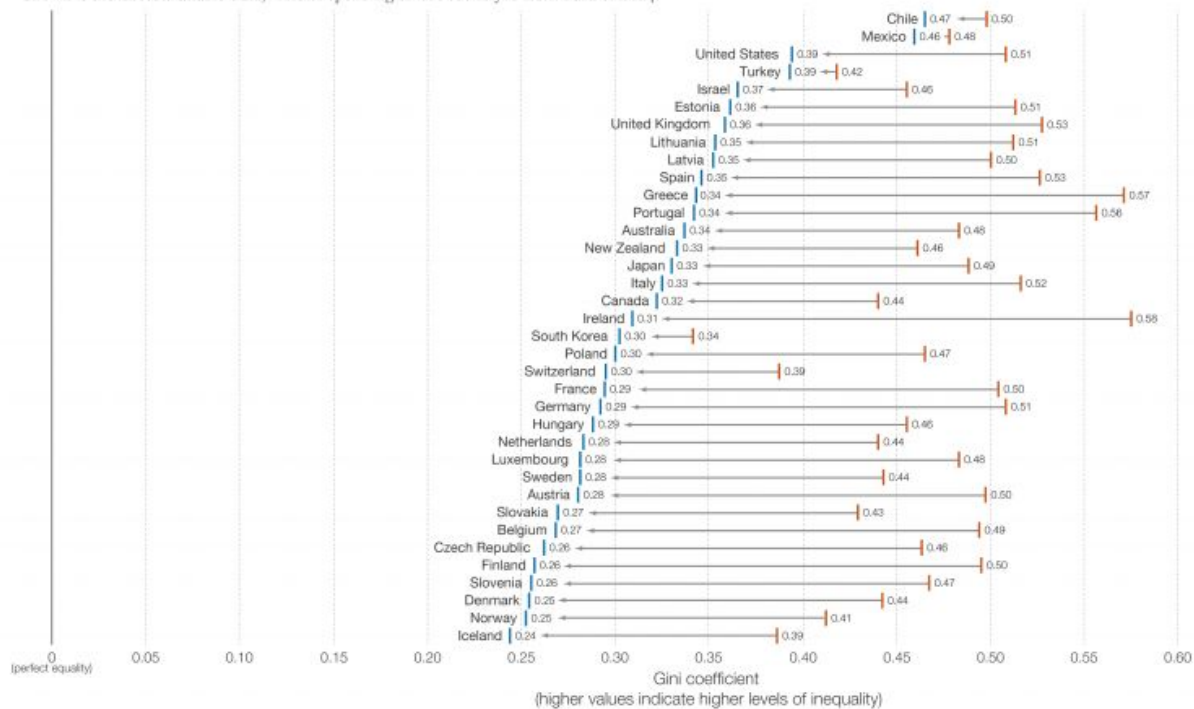
OurWorld  
in Data

Inequality of incomes, as measured by the Gini Coefficient. Higher values reflect more inequality.

The red bar shows the level of 'market income' inequality (gross wages and salaries + self-employment income + capital and property income).

The blue bar shows the level of disposable income inequality (disposable income = market income + social security cash transfers + private transfers - income tax).

Shown is the latest available data, which depending on the country is from 2012 to 2014.



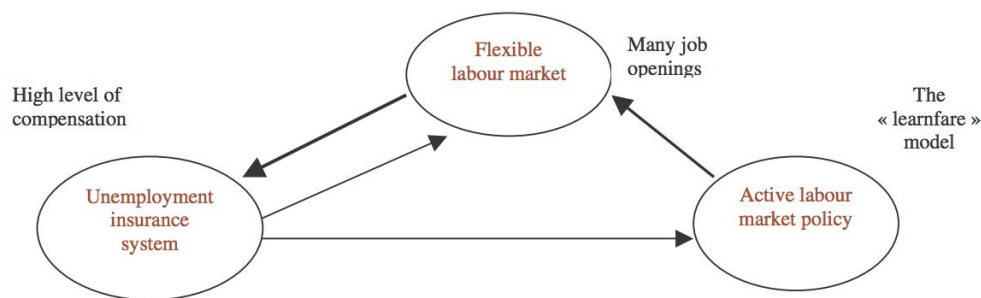
Data source: OECD

The data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualizations on this topic.

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(Figure 3: The effect of redistribution on Denmark's inequality index)

The top 10% of the Danish income population have to pay 51% income revenue as tax compared with 45% as average Dane. As a result, Denmark provides social protection policy for all citizens, including free education, free healthcare and enormous subsidies for the poor (*Decent Work Pilot Programme - Country Brief: Denmark*, n.d.). The third foothold to keep the first two policies not fall apart is its active labor market policy, through which the unemployed are required to actively participated in finding new employment opportunities and receiving new training for skills (see Figure 4). Like any other Nordic countries, The Danish Confederation of Trade Unions is the driver behind the scene. The labor market is co-regulated by trade unions and employers' organizations as they agree upon how to define wages and working conditions (*The Danish labour market model*, n.d.). The safety net coupled with incentives for flexible employment allows thriving economy as well as low inequality to coexist.



The golden triangle of “flexicurity”, Madsen, 2001

(Figure 4: An illustration of Danish active labor market policy model)

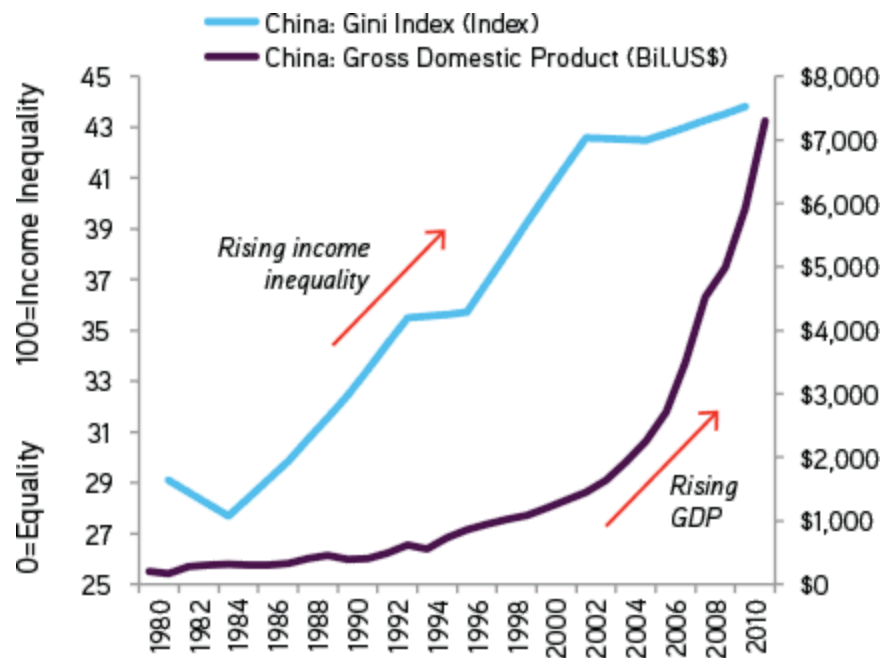
### China - Centrally planned economic development without alternative levers

China, as a contrast, has experienced huge economic growth in the recent decades with impressive technology advancement as well as widening income inequality. Many scholars argue that the current inequality in China is a necessary stage in economic development, as illustrated by Kuznets’ curve that countries with middle GDP per capita tend to have high income inequality index. From Figure 5 (McVey, 2013) we can see two jumps of China’s inequality index, around 1984 and late 1990s respectively. The first jump reflects the slowly mounting effect from 1978 Open Door policy by president Deng who liberalized Chinese market and brought huge economic growth to the country. Foreign direct investment (FDI) rushed into China which created gambling opportunities for people to go rich or bankrupt in a night. Horizontal inequality grew between rural and cities (especially those that are allowed to be liberalized first) because national policy has poured tremendous amount of resources into cities and appropriating rural labors without providing sufficient social care<sup>5</sup>. The second jump is the result of privatizing nation-owned enterprise in late 1990s when large amount of workers were laid off, unemployment rate and income inequality spiked.<sup>6</sup> Aside from these structural changes in economic system, lack of alternative levers is another key for growing inequality. Different from Denmark, in China, government is the biggest driver behind any economic change and inequality adjustment. Labor union and NGOs are heavily repressed in such political environment as communist party sees them with the potential to “disrupt social order”. Without

<sup>5</sup> For example, China’s “Hukou” identification system starting from 1950s segregated rural and city citizens. Large amount of rural workers to flux into cities in 1990s to work in factories driving China’s export-driven economy were excluded from the social welfare system in the city due to their identification, as well as education for their kids. Economic growth in cities is built upon their sweat and tears and the sacrifice of villages as their labors and resources were drained. National policy by Deng even explicitly said that “we allow a small group of people to get rich first” as the guideline for 1990s econ development.

<sup>6</sup> Workers who used to work in nation-owned enterprise were trained in very specific skillsets with all their social welfare covered (e.g. kids’ education, healthcare) had their “life contracts” broken due to this privatization policy. Many are not well-prepared to adjust to competitive labor market. Meanwhile in the process of privatization, many individuals acquire capitals such as factories that used to belong to the nation as their individual possessions, drastically increases personal wealth.

these contrarians, China has prioritized economic development and in the past decades with lagging social welfare system to protect workers' rights.<sup>7</sup>



(Figure 5: China's growing GDP and Gini Index historical trend).

### South Korea - State investment in education and ICT infrastructure

South Korea stands between Denmark and China's model. Despite similar economic development path (export-driven growth model) and deep cultural tradition in collectivism, it achieved "growth with equity" from the 1960s to 1980s with tremendous economic growth, while successfully avoided the curse of rising inequality according to Kuznets' curve (K.S., 2006).<sup>8</sup> Interestingly, Korean scholars attribute part of the reasons of "growth with equity" to the same export-driven economic growth model as China and argue that the rapid industrialization created abundance amount of job opportunities for people to move from rural villages to cities with improved wages (K.S., 2006). The reason that it works for South Korea but not China is that most of the export growth benefits concentrate at cities and Korea has 80% of its population urbanized by 2010 (from 30% in the 1960s to 80% to 2010), while China with a much larger "horizon" to cover, has only urbanized 50% of its population. Another factor that keeps inequality down is government's investment in education and ICT infrastructure. South Korea adopted mandatory free public education for kids below 18 since the 1960s, way earlier than China which starts in 1990s, resulting in the highest tertiary gross enrollment ratio in the world. It's

<sup>7</sup> China actually have some labor unions, but most of them are controlled by the party. Therefore workers in China cannot use their leverage against the market, such as organizing strikes. They also don't have much political voice as China is not a democratic regime, so when technology comes and causes chaos in labor market, workers are the most vulnerable group.

<sup>8</sup> Kuznets' curve stated that as an economy develops, market forces first increase and then decrease economic inequality. It's like a bell shape with income per capita at x-axis and inequality on y-axis.

driven by both the Confucians culture tradition and the need to adapt to fast-changing labor demand when the compositions of export shift from manufacturing to machinery and electronics<sup>9</sup>. Furthermore, by 2015, 90% of Koreans and Danish are internet users (internet penetration rate), compared with only 50% in China, with the fastest internet speed in the world. Korean government, behind the scene, provided tax cut to ICT industries in early days, while encouraging fierce competitions in the field, with 3.6 billion dollars investment in R&D of core ICT technology (Nam Lee, n.d.). Such ICT coverage enables web-based education technology products to thrive in every corner of the nation<sup>10</sup>, integrating into a positive feedback loop to IT-based economic growth and reducing income inequality.

In summary, we learned that historically, inequality rises with technology advancement, but we cannot ignore the variations in the model, which sheds lights on the wisdom from different countries to strike a balance. Denmark and South Korea's stories reveal the constraints of inequality reduction in China, such as the lack of democratic levers to counterbalance and the difficulty of the depth and width of the problem due to a large population and geographic coverage.

## **PREDICTION OF CHINA'S FUTURE INEQUALITY**

I argue that the introduction of online coding education (OCE) technology, specifically those focus on coding education, will drastically close education inequality gap, but not necessarily the income inequality gap.

### **Increasing tensions and national policy focus on addressing Inequality**

In China, everything works in a top-down way. People can easily predict what will be a hit in the future by just looking at the guideline documents issued by the government and actions taken by the government. Following this principle, I want to start off with some top news headline in the past two months in China. First of all, President Xi announced a major change in the first principle (which has not been changed since 1981!!) guiding China's future development during China's Communist Party 19th National Congress meeting. The main conflict in society is not about the imbalance between increasing demands and lacking productivity any more, but about the imbalance between people's demand for better lives and unequal development (Fu, 2017). It means China is ready to move from prioritizing economy to prioritizing equality. Secondly, Shenzhen has experimented with a self-driving bus route and the only obstacle for putting those buses into official use is to "wait for transportation regulation policy to catch up" (*First time in China! Shenzhen's automatic bus route is open, 2017*). Jingdong, one of the biggest e-commerce company announced its first automatic package

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<sup>9</sup> From Economic Complexity Observatory we can see that South Korea's development path has shifted toward IT-based exports in recent decades and that require the education to catch up with the labor demand from industries. Confucian culture tradition emphasizes on education just like any other East Asian Countries.

<sup>10</sup> For example, Megastudy, the most famous online test prep platform has 50% of high school seniors as members with high quality teaching and affordable access, further equalizing the education resources in the country.

processing system that will be put into use (*Jingdong's most advanced technology*, 2017). What all these imply is that the clock is ticking: both private and public sectors have huge incentives to adopt technology as fast as possible in the race<sup>11</sup>. Without a democratic negotiation between the employers and employees (like Denmark) to adapt quickly, even if the top leadership is aware of the problem, it takes a long time for corresponding policy to trickle down to local government and have the labor market prepared for the change<sup>12</sup>.

### **The Rise of Coding Education**

As we know, when the age of AI comes, the labor market will be polarized into low-end caretaking jobs and high-end technical jobs, while the latter requires a lot more training. The State Council (国务院) in China this year issued *AI Development Planning Document*, in which it says primary schools, middle schools and high schools curriculum will integrate AI education into their curriculum, as an education requirement for future generations (*State Council's new AI development Planning Announcement*, 2017). Zhejiang province, one of the richest and most educationally advanced province announced couple weeks ago that information technology will be included, the first time in history, as a major course for college entry exam. These policies are signals that government is tackling the root problem, which is to transform a whole generation of students to be equipped with adaptive abilities to technology and hopefully reduce income gap.

### **Online Coding Education Narrows Education Inequality**

Coding education is the fundamental of any AI education, but it requires highly educated teachers and technology supports. With current educational resource divide, kids in economically and educationally advanced regions are more likely to take off on the route first, which keeps widening education inequality, especially if such education is required in the “fairest” exam rural kids can take to enter colleges. Online coding education (OCE) technology will still be constrained by the digital divide, but solves the problem of lack of qualified “teachers” (AI) and good contents which are the biggest challenge to unprivileged schools. The two constraints discussed above, the lack of democratic levers and the need for scalability to cover the population and geographic depth, can be satisfied with such technology as well.<sup>13</sup> NGOs and private sector can avoid the politically sensitive work such as organizing labor protests, but instead focusing on creating scalable OCE that charge rich city families and schools for money

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<sup>11</sup> For example, automatic package processing system not only improves package sorting, packing and delivery efficiency which lower the costs for the company, but also avoids human error, use less packaging materials (environmentally friendly) and reduce management complexity. There has not been estimation of how many mailman's job will be reduced due to this technology and the amplification is not clear since it was announced only a week ago.

<sup>12</sup> #context: Situate my prediction under the context of China's recent moves and (in previous sections) analyze the variations under the context of Denmark and South Korea.

<sup>13</sup> #constraints: use case studies of Denmark and South Korea to reveal the constraints for China to reduce inequality and analyze how OCE satisfy and help break those constraints.



to subsidize free services given to rural or unprivileged schools<sup>14</sup>. Despite no empirical and rigorous evidence found around the effect of large scale implementation of coding education, Samuel Papert (1980), the inventor of Scratch, demonstrates in his the book *Mindstorm* the social aspects of coding: it requires collaborations more than any other subjects and teaches kids valuable life lessons such as persistence and patience through the training of debug. His experiments also showed that students who are bad at math can be good at computer science and get better at problem-solving and analytical skills. These are the social knowledge that unprivileged kids lack the most.

### **Online Coding Education's Impact of Income Inequality**

It's tough to argue for online coding education's impact on income inequality. OCE is just one of the many strings that attach to the ultimate income inequality<sup>15</sup>. In the short run, people are more likely to find jobs in the market if they are trained in computer science, especially for those from the unprivileged background. On the other hand, people might just become a new generation of "IT slaves" coding for the profits of others. Harrari (2015) in his book points out that governments are incentivized to abandon democracy in the age of AI. Traditionally, governments care about voters because they are part of the economy (and that's also labor union's leverage), but now when AI becomes the main player in the economy, people are losing economic values as well as political values to governments. Income gap might shoot up quickly because the production materials (AI) will more be centralized in the hands of a few. Considered Chinese government's past preference for collective goods rather than individual rights, it's very plausible that the communist party will turn into an autocratic regime. In fact, the recent document released from the 19th National Congress meeting shows that the party began to steer toward right wing, giving a halt to the period of "economic liberation" since 1978.<sup>16</sup>

In summary, inequality tends to rise with technology advancement in human history, but people have also learned to counterbalance it through institutions, tax, labor unions and all sorts of market tools which ends up to be the variations we see today. Denmark and South Korea reveals both political constraints (lack of democratic levers) and geographic constraints (the depth and width of China's inequality problem due to large population and grand geographic coverage) for China's struggle with inequality. Online coding education platform is very likely to drastically reduce education inequality in China leveraging both the advantage of the scalability

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<sup>14</sup> Global Youth Network at HongKong is one of such NGOs that it is building a platform integrating MIT's best coding curriculum such as Scratch and App Inventors with AI teachers and will give this platform for free to unprivileged schools that are struggling to find good education support for teaching such subject.

<sup>15</sup> Factors such as political environment as illustrated below, power dynamics, wealth distribution and the speed of wealth accumulation for the top will need to be account of in considering income gap.

<sup>16</sup> Left wing in China means support for liberalized markets, free speech, human rights, internet freedom, while right wing implies more centralized control, more government interventions in everything. For example, companies in China usually has a CEO board and party directors. In the past decades, CEO board has more power than the party director at deciding important affairs, but now after the 19th Congress meeting, party directors have more power than CEOs and all business final decisions need to go through the party directors in the companies.

of such technology and encouragements from policies, but whether this will also reduce income inequality is questionable depending on future political dynamics<sup>17</sup>.

## REFERENCE

*For Richer, For Poorer*. (2012). Retrieved from

<http://www.parisschoolofeconomics.com/reshef-ariell/Media/The%20Economist%20special%20report%20October%2013%202012.pdf>

magdalena, s. (2015). *Where does social inequality come from? Hunter-Gatherer to Agriculture*. UCL Public Policy Analysis. Retrieved 9 December 2017, from

<https://uclpublicpolicyanalysis.wordpress.com/2015/01/31/where-does-social-inequality-come-from-hunter-gatherer-to-agriculture/>

*Decent Work Pilot Programme - Country Brief: Denmark*. Retrieved from

<http://www.ilo.org/public/english/bureau/dwpp/download/denmark/countrybriefdk.pdf>

*GDP per capita (current US\$) | Data*. *Data.worldbank.org*. Retrieved 9 December 2017, from

<https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=DK-US-1W-KR-CN>

Income Inequality (n.d.). *Our World in Data*. Retrieved 9 December 2017, from

<https://ourworldindata.org/income-inequality/>

*The Danish labour market model*. *Danish Business Authority*. Retrieved 9 December 2017, from

<https://danishbusinessauthority.dk/danish-labour-market-model>

Thompson, D. (2016). *The American Dream Isn't Alive in Denmark*. *The Atlantic*. Retrieved 9 December 2017, from

<https://www.theatlantic.com/business/archive/2016/08/the-american-dream-isnt-alive-in-denmark/494141/>

Atkinson, A., & Sogaard, J. (2015). The Long-Run History of Income Inequality in Denmark. *The Scandinavian Journal Of Economics*, 118(2), 264-291. <http://dx.doi.org/10.1111/sjoe.12143>

McVey, H. (2013). *Outlook for 2013: A Changing Playbook | KKR*. *Kkr.com*. Retrieved 9 December 2017, from

<http://www.kkr.com/global-perspectives/publications/outlook-2013-changing-playbook>

Wiking, M. (2016). *Why Danes Happily Pay High Rates of Taxes*. *U.S. News*. Retrieved 9 December 2017, from

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<sup>17</sup> #induction. This whole paper is trying to make an induction in the form of prediction generalizing from evidence in the history, in variational case studies and news and policy analysis.

<https://www.usnews.com/news/best-countries/articles/2016-01-20/why-danes-happily-pay-high-rates-of-taxes>

Claeys, G. (1984). Engels' Outlines of a Critique of Political Economy (1843) and the Origins of the Marxist Critique of Capitalism. *History Of Political Economy*, 16(2), 207-232.  
<http://dx.doi.org/10.1215/00182702-16-2-207>

Report | *The Web Index*. *Thewebindex.org*. Retrieved 10 December 2017, from <http://thewebindex.org/report/>

*Income Inequality*. *Our World in Data*. Retrieved 10 December 2017, from <https://ourworldindata.org/income-inequality/>

京东晒黑科技：全球首个无人货仓 (*Jingdong's most advanced technology: The first automatic package processing system in the world*). (2017). *Tech.qq.com*. Retrieved 10 December 2017, from <http://tech.qq.com/a/20171009/069062.htm>

Papert, S. (1980). *Mindstorms*. New York: Basicbooks.

Nam Lee, B. *Korean government-driven ICT policy: IT 839 strategy*. Retrieved from <https://www.itu.int/ITU-D/finance/work-cost-tariffs/events/tariff-seminars/kuala-lumpur-05/presentation-lee.PDF>

Harari, Y. (2015). *Homo deus: A Brief History for Tomorrow*. Israel.

*Do more equal societies produce more patents? Some very preliminary data (2010)*. *Ipkitten.blogspot.kr*. Retrieved 10 December 2017, from [http://ipkitten.blogspot.kr/2010/02/do-more-equal-societies-produce-more\\_01.html](http://ipkitten.blogspot.kr/2010/02/do-more-equal-societies-produce-more_01.html)

国务院关于印发新一代人工智能发展规划的通知（国发〔2017〕35号） (*State Council's new AI development Planning Announcement*). (2017). *Gov.cn*. Retrieved 10 December 2017, from [http://www.gov.cn/zhengce/content/2017-07/20/content\\_5211996.htm](http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm)

K.S., J. (2006). *Growth with Equity in East Asia?*. Economic and Social Affairs. Retrieved from [http://www.un.org/esa/desa/papers/2006/wp33\\_2006.pdf](http://www.un.org/esa/desa/papers/2006/wp33_2006.pdf)

Fu, S. (2017). *中国传媒研究计划 / 中共十九大报告语象分析 (Analysis of 19th Congress Meeting in China)*. *中国数字时代*. Retrieved 10 December 2017, from <https://chinadigitaltimes.net/chinese/2017/11/%E4%B8%AD%E5%9B%BD%E4%BC%A0%E5%AA%92%E7%A0%94%E7%A9%B6%E8%AE%A1%E5%88%92%E7%BD%9C%E4%B8%AD%E5%85%B1%E5%8D%81%E4%B9%9D%E5%A4%A7%E6%8A%A5%E5%91%8A%E8%AF%AD%E8%B1%A1%E5%88%86%E6%9E%90/>

The economy. (n.d.). *Technological change, population and economic growth*. (2.0-2.9). Retrieved from [http://www.core-econ.org/wp-content/uploads/2015/09/Unit2\\_Sept2015.pdf](http://www.core-econ.org/wp-content/uploads/2015/09/Unit2_Sept2015.pdf)

中国首次！深圳无人驾驶公交车正式上路 (*First time in China! Shenzhen's automatic bus route is open*). (2017). Sohu.com. Retrieved 10 December 2017, from [http://www.sohu.com/a/208302021\\_114760](http://www.sohu.com/a/208302021_114760)