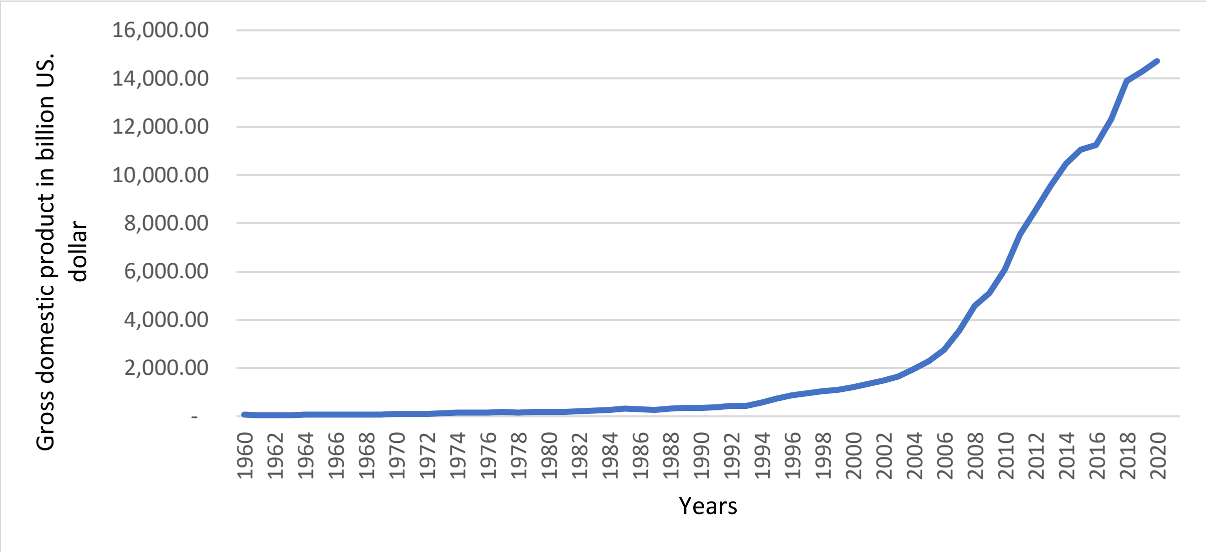
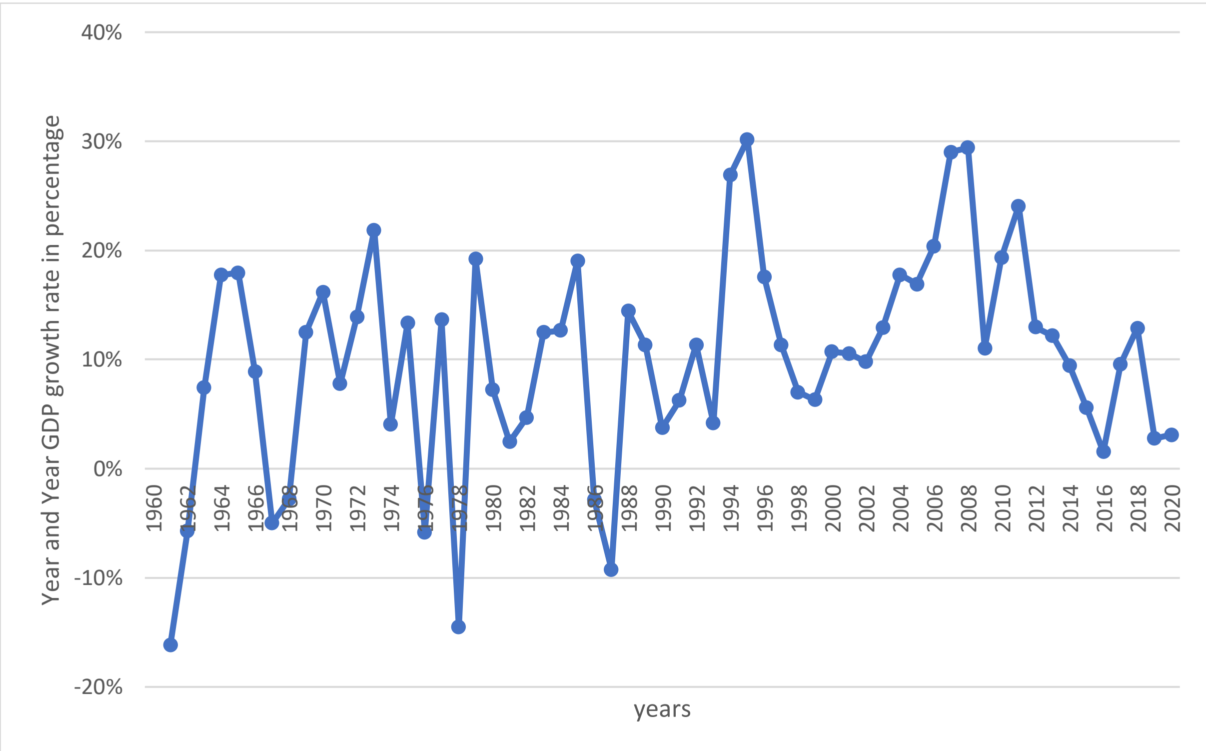
# Appendix A

Table 1 China's Gross domestic product in billion USD for the period 1960 to 2020




*Source Trade Maps ITC 2020*

Table 2 China's Year and Year GDP growth rate in percentage for the period 1960 to 2020




*Source Trade Maps ITC 2020*

The first graph describes the value of China's gross domestic product for each year from 1960 to 2020. The second graph describes the growth rate of the GDP over the same period. It can be seen that the growth of the GDP only starts from the liberalization process in 1979. But it remains moderate until 2000. After that, China enters the WTO and exports a lot, which ensures the growth of the country. Since 2018, we observe that the growth is trying to stabilize, or even decrease.

# Appendix B

**Solow-Swan model (1956)**

The model was developed independently by Robert Solow and Trevor Swan in 1956. According to the Solow-Swan model of exogenous growth (1956), long-run economic growth is explained by the accumulation of physical capital, labor, human capital and increases in productivity due in large part to technological progress. Growth is defined according to a Cobb-Douglass function which is as follows:

$$Y = AK^{\alpha}(LH)^{\beta}$$

$Y$ is a measure of output, $A$ is total factor productivity, $K$ is physical capital, $L$ is labor, while $H$ is human capital. $\beta$ and $\alpha$ is the distribution of capital and labor in final output.

*Source: Solow, 1956*

## Appendix C

**Acemoglu, Aghion and Zilibotti model (2006)**

Thus, according to the model of Acemoglu, Aghion and Zilibotti (2006), when companies receive investments, physical capital (*K*) increases and this generates growth (*Y*) in the first phase of development (before the technological frontier).

Technical progress that comes from foreign firms (FDI) involves an increase in production from a given combination of factors of production (*K, L* and *H).* For example, a new (mechanical) grease that allows machines to run at higher speeds and thus produce more. In our equation, this is characterized by an increase in productivity, *A*.

As with physical capital, the creation of a new technology requires investment. Investments in technical progress are known as research and development (R&D) (Solow, 1956).

Once the technological frontier is reached, it becomes impossible to grow through the accumulation of physical capital and the assimilation of foreign technology. The country that has reached the frontier can no longer use the reallocation of resources to productive activities. The only way to evolve is to promote innovation and human capital, *A* and *H* (Acemoglu, Aghion, and Zilibotti, 2006).

*Source: Acemoglu, Aghion and Zilibotti model, 2006*

# Appendix D

**Growing Like China by Zheng Song, Kjetil Storesletten, and Fabrizio Zilibotti**

The reallocation of resources that leads to an increase of productivity in China was developed sooner. This intuition of Fabrizio Zilibotti was developed deeply by himself and other specialists: Zheng Song and Kjetil Storesletten. They believe that the transition from the first phase of development to the technological frontier is achieved through a transition period characterized by a reallocation of resources between state and private enterprises.

The text focuses on the transition that took place after 1992. In 1997, after the 15th Tale of the Communist Party, the role of private enterprises is strengthened. The growth rate remained stable. The return on capital in general has fallen slightly despite many investments. However, it increased sharply in the manufacturing sector between 1990 and 2003.

They have constructed a model abled to deal with high growth and high return on capital. That occurred in China, but it could be confusing because: Open economy model predicts a higher return to capital when inflow of capital is higher than the outflow of capital. And closed model predicts that increasing capital in an economy decreases internal returns. So, the model will try to restore the truth. The central point is the reallocation of resources between firms. Also, the model considers market imperfections and frictions.

Reallocation of capital and labor from less productive externally financed firms to more productive entrepreneurial firms with less access to external financing led to sustained returns to capital and increased activity abroad.

Economic model in which productive firms but with little access to the financial market and which rely on their profits to invest. There also exist less productive firms but they have easily access to the financial market. Frictions and imperfections in the financial market allow less productive firms to survive and even outperform productive firms.

Number of financially integrated firms shrink due to the strong concurrence of productive firms. When savings are sufficient, productive firms can crowd out less productive firms from the market. If there are less financially integrated firms, the need for funds decreases too. More domestic savings are invested in foreign assets. Investment of firms in expansions financed by profits. Especially since, according to a study by Jian Wang and Xiao Wang, foreign-acquired domestic companies have sufficient reserves to counteract the inefficiency of financial markets. Employees have money to invest. They fly to invest in the demand of foreign bonds OR in domestic companies. The demand for funds from domestic companies decreases. More funds go abroad, creating a growing foreign surplus. These foreign assets generate returns and profits. Thus, a high growth and a high investment is consistent with the accumulation of a foreign surplus.

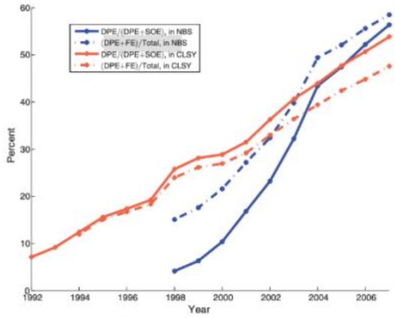



FIGURE 2. PRIVATE EMPLOYMENT SHARE

:

*Note:* (ECD+FE)/(ECD+FE+SOE+COE) is the dotted line; proportion of domestic private enterprise = ECD. ECD was low until 1997 and that most of the transition occurred thereafter. This is consistent with the political events described above. In fact, in china, the SOE was predominant during the first year of its development. The liberalization of its economy was made over time. Source: CSY and CLSY, various issues.

We can see that private enterprises have strongly increased during China's transition process after 1992. Compared to the national and state-owned enterprises, which are not very productive, which are decreasing. As we said sooner, ECDs and SOEs differ in two important respects: productivity and access to capital markets. SOEs are, on average, less productive and have better access to external credit than SOEs. In general, we observe an increase of productivity in China due to the existence of more productive firms.

So, the low total factor productivity comes from a misallocation of resources at the micro level. A country in a state of inequity can use reallocation and thus grow rapidly. Thanks to efficient firms that can rely on a highly elastic supply of factors attracted by less productive firms.

In an influential paper, Hsieh and Klenow (2009) find that reallocation among manufacturing firms with different productivities is responsible for a two-percentage point annual increase in aggregate TFP between 1998 and 2005. Loren Brandt, Johannes Van Biesebroeck, and Yifan Zhang (2009) estimate that up to two-thirds of the overall TFP growth in Chinese manufacturing was due to productivity differences between inbound and outbound firms between 1998 and 2005.

In a cross-country study, Franklin Allen, Jun Qian, and Meijun Qian (2005) find that China performs poorly in terms of creditor rights, investor protection, accounting standards, non-performing loans, and corruption.7 = = => As a result, SOEs may finance a larger share of their investments through external financing.
We take account of income inequality: Provinces with more private firms have significantly higher income dispersion.

Changes in net surplus and productivity growth as a function of the SOE to ECD transition

TABLE 1

| Dependent variable | (S-I)/GDP (1) | (S-I)/GDP (2) | Growth rate of GDP p.c. (3) | Growth rate of GDP p.c. (4) | Growth rate of VA p.w. (5) | Growth rate of VA p.w. (6) |
|---|---|---|---|---|---|---|
| D.($EMPL^{PRIV}$) | 0.9964** (0.4889) | 0.8920* (0.4659) | 0.1893*** (0.0603) | 0.1903*** (0.0610) | — | — |
| D.($EMPL^{NONSOE}$) | — | — | — | — | 1.4257*** (0.4785) | 1.5973*** (0.3572) |
| L.(GDP p.c.) | — | 6.6268*** (2.3952) | — | −0.0646 (0.2136) | — | — |
| L.(VA p.w.) | — | — | — | — | — | 0.1283*** (0.0152) |
| Year dummy | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 124 | 124 | 124 | 124 | 112 | 112 |
| $R^2$ | 0.0424 | 0.1984 | 0.2252 | 0.2258 | 0.2104 | 0.2577 |

*Notes:* Dependent variables: (S-I)/GDP*100 is the provincial ratio of net surplus over GDP. S and I stand for aggregate savings and investment, respectively. S = GDP − C − G, where C and G are household consumption and government consumption expenditures, respectively. GDP p.c. is the real provincial GDP per capita in the value of 10 thousand RMB (adjusted by provincial GDP deflators). VA p.w. is the industry value-added per worker (10 thousand RMB). Growth rates are in percent. Regressors: $EMPL^{PRIV}$ is equal to DPE/(DPE + SOE)*100, i.e., the ratio of private employment over the sum of private and state employment. $EMPL^{NONSOE}$ is equal to (1 − SOE/Total)*100, i.e., the ratio of non-SOE employment over total employment. D.(·) and L.(·) stands for the difference and the one-period lag, respectively. Standard errors clustered at the province or industry level. Robust standard errors are in brackets.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Source: Growing Like China, 2011

This table confirms previous intuitions. Net surplus increased in regions where the transition from SOE to ECD is more important (change in business/resource allocations). Labor productivity increased faster in provinces where the share of ECD employment increased faster.

*Source: Song, Storesletten, and Zilibotti, 2011*

# Appendix E

**Ricardian model (1817)**

Ricardo's model of comparative advantage is probably one of the simplest and most widely used models of international trade. According to the model, each country should produce the good for which it has a comparative advantage when international trade is possible. That is, one will concentrate its resources on the production of some goods and trade the surplus with the other country. It means that a country doesn't specialize in a good that is relatively more difficult to produce compared to other countries. Domestic country acquires goods that it doesn't produce, and the opposite occurs in the foreign country. This reasoning can be applied to a larger number of goods (Krugman et al. 2018).

Emerging economies in world trade have induced a much higher degree of international specialization than observed in previous decades. Developing countries are gradually entering international trade. Most countries in the world are forced to specialize in production to secure a place in international trade. High-income countries are using goods produced by less advanced economies and turning them into finished products with better technology and a more skilled workforce. Previously, only gravity models were useful in trade analysis when North-North trade took place (Eaton and Kortum 2002 and Hanson 2012).

**The model**:

As a reminder, this model assumes an economy with N goods, 2 countries and 1 factor of production. It also assumes a linear production function in a competitive market. This implies that the price of a good is equal to the product of productivity and the worker's wage. Foreign investors choose in which country to invest depending on this comparative advantage. The price of the good *i* is lower in home country than in the foreign country if $p_i < p_i^*$. So,

$aL_i w < aL_i^* w^*$

the home country should produce all goods for which

$aL_i^*/aL_i > w/w^*$

The left side describe how much more productive is home compared to foreign in *i*. While the right side describes how more expensive is home compared to foreign labor. A country produces goods when the ratio of its wage to the foreign wage ($w/w^*$) is less than the ratio of foreign labor productivity to domestic labor productivity ($aL_1^* / aL_1$). It is impossible for each country to produce several goods at the same time in an open economy. They can produce one good and trade it with the rest of the world to acquire the other one. Each country sells its goods at a higher price than if it were in autarky because the foreign country is willing to buy it at a higher price.

If the ratio w/w* increases as in China and labor productivity remains fixed in each country, the number of goods produced by foreign countries will be higher. In this case, the number of goods produced in China decreases and less investment will take place in the country because it becomes too expensive to produce in the country. If a wage increase occurs, a country can continue to produce goods if productivity is relatively high compared to other countries. This simple model can highlight an interesting fact about China's competitiveness relative to the rest of the world. If China simply observes a wage increase without improving its productivity, it will become unattractive to invest and produce in China and investors will produce in countries with the same level of productivity and lower wages (C. Feenstra and M. Taylor, 2012).

*Source: Feenstra and Taylor, 2012*

# Appendix F

**<u>Cheng, C. (1971). The Economy of Communist China, 1949–1969 (p. 89). University of Michigan Press.</u>**

China has not always been a major destination for foreign investment. Between 1949 and 1976, the country was ruled by the Communist Party founded by Mao Zedong. It consisted of pooling resources to improve only certain sectors, such as agriculture and industry, thus preventing the development of a competitive economy (Kaiser & al., 2006). According to China's official statistics, these measures seem to have worked, as industrial exploitation increased by an average of 18% per year between 1952 and 1957 and reached 66% and 39% in 1958 and 1959, respectively (Cheng, 1971).

However, China was poor and its expansion stagnated during the Mao regime. China's GDP remained constant between 1952 and 1979 instead of increasing like the United States. The U.S. GDP reached $7,299,041 million in 1979 while China's GDP only reached $1,719,669 million (China Statistical Yearbook, 2020).

Table 4

Production and Per Capita Availability of Foodgrains, 1952-68

| Year | Foodgrain output (million tons) | Exports(-) or imports(+) (million tons) | Total availability of foodgrains (million tons) | Population (million persons) | Foodgrains per capita (kg.) |
|---|---|---|---|---|---|
| 1952 | 154 [1] | | 154 | 569 [11] | 270 |
| 53 | 157 [1] | -1 [8] | 156 | 581 [11] | 269 |
| 54 | 161 [1] | -1 [8] | 160 | 595 [11] | 270 |
| 55 | 175 [1] | -1 [8] | 174 | 608 [11] | 286 |
| 56 | 183 [1] | -1 [8] | 182 | 621 [11] | 293 |
| 57 | 185 [1] | -1 [8] | 184 | 635 [11] | 290 |
| 58 | 200 [2] | -1 [8] | 199 | 645 [12] | 308 |
| 59 | 175 [2] | | 175 | 655 [12] | 267 |
| 60 | 150 [3] | +1 [8] | 151 | 665 [12] | 227 |
| 61 | 162 [3] | +5 [8] | 167 | 675 [12] | 248 |
| 62 | 174 [3] | +5 [8] | 179 | 685 [12] | 261 |
| 63 | 183 [3] | +5 [8] | 188 | 695 [12] | 271 |
| 64 | 195 [4] | +5 [8] | 200 | 706 [12] | 283 |
| 65 | 200 [3] | +6 [8] | 206 | 717 [12] | 287 |
| 66 | 205 [5] | +5 [9] | 210 | 728 [12] | 288 |
| 67 | 215 [6] | +4 [9] | 219 | 739 [12] | 296 |
| 68 | 210 [7] | +4 [10] | 214 | 750 [12] | 285 |

Table 2

Industrial Production Indexes, 1949-59

(1952=100)

| | (1) Official gross output value index[1] (factory & handicraft) | (2) Chao's gross output value index[1] (factory & handicraft) | (3) Liu-Yeh value-added index[2] (factory only) |
|---|---|---|---|
| 1949 | 40.8 | 50.0 | |
| 50 | 55.7 | 63.3 | |
| 51 | 76.8 | 81.2 | |
| 52 | 100.0 | 100.0 | 100 |
| 53 | 130.2 | 122.1 | 122.9 |
| 54 | 151.4 | 139.4 | 142.2 |
| 55 | 159.8 | 149.7 | 159.0 |
| 56 | 205.0 | 179.4 | 210.8 |
| 57 | 228.3 | 189.8 | 238.6 |
| 58 | 379.4 | 251.5 | 289.2 |
| 59 | 528.6 | 330.9 | 373.5 |
| Average annual rate of growth | | | |
| 1952-57 | 18.0 | 14.4 | 19.4 |
| 1952-59 | 26.9 | 20.6 | 21.1 |
| 1949-59 | 29.2 | 23.7 | n. a. |

*Source: Cheng, C. (1971)*

## Appendix G

Table 3 China's export products to the rest of the world for the period 2016 to 2020 in which China has a comparative advantage.

| Code | average (X product/ X tot) | average (X product/Xtot) | RCA | average X | average M | trade surplus | Comprative advantage |
|---|---|---|---|---|---|---|---|
| 85 | 0,267373804 | 0,14643147 | 1,82593128 | 640316651 | 487389983 | 152926668 | VRAI |
| 84 | 0,168271264 | 0,11817953 | 1,42386137 | 402982232 | 180424908 | 222557324 | VRAI |
| 94 | 0,040472721 | 0,0141451 | 2,8612541 | 96925565 | 3467551,6 | 93458013,4 | VRAI |
| 63 | 0,01533175 | 0,00429132 | 3,57273633 | 36717041 | 668871,4 | 36048169,6 | VRAI |
| 95 | 0,0243083 | 0,00650948 | 3,73429347 | 58214414,6 | 2274291,8 | 55940122,8 | VRAI |
| 73 | 0,026438385 | 0,01629418 | 1,62256617 | 63315620,4 | 9939414,2 | 53376206,2 | VRAI |
| 62 | 0,028974527 | 0,01256528 | 2,30591994 | 69389266,2 | 4161722,2 | 65227544 | VRAI |
| 61 | 0,029581023 | 0,01271807 | 2,32590473 | 70841725,8 | 3146747,6 | 67694978,2 | VRAI |
| 64 | 0,019149179 | 0,00777514 | 2,46287222 | 45859161 | 4594122,2 | 41265038,8 | VRAI |
| 69 | 0,009381635 | 0,00316212 | 2,96687842 | 22467486,2 | 1132795,6 | 21334690,6 | VRAI |
| 76 | 0,010166972 | 0,00967765 | 1,05056222 | 24348240,6 | 6627479 | 17720761,6 | VRAI |
| 42 | 0,01161986 | 0,00439813 | 2,6420006 | 27827668,6 | 3390343 | 24437325,6 | VRAI |
| 89 | 0,009744125 | 0,00699797 | 1,39242172 | 23335591,2 | 2007520,4 | 21328070,8 | VRAI |
| 83 | 0,007705308 | 0,00384271 | 2,00517297 | 18452955,6 | 1838820,2 | 16614135,4 | VRAI |
| 96 | 0,006988084 | 0,00291475 | 2,39748608 | 16735321,2 | 2369487,2 | 14365834 | VRAI |
| 70 | 0,007062635 | 0,00415046 | 1,70165141 | 16913857,8 | 7458681 | 9455176,8 | VRAI |
| 54 | 0,007973834 | 0,00266039 | 2,99724416 | 19096031,8 | 2833690,8 | 16262341 | VRAI |
| 82 | 0,006583884 | 0,0035995 | 1,82911012 | 15767329,2 | 3468072,6 | 12299256,6 | VRAI |
| 60 | 0,007022286 | 0,00194608 | 3,60843516 | 16817229,4 | 1484994,2 | 15332235,2 | VRAI |
| 68 | 0,004961145 | 0,00296052 | 1,67576662 | 11881132,4 | 1734792 | 10146340,4 | VRAI |
| 55 | 0,004956331 | 0,00197309 | 2,51196426 | 11869603,4 | 2155738,4 | 9713865 | VRAI |
| 86 | 0,004175219 | 0,00206411 | 2,02277215 | 9998969 | 811402,8 | 9187566,2 | VRAI |
| 7 | 0,004362156 | 0,00411012 | 1,06132155 | 10446652,8 | 1880194,8 | 8566458 | VRAI |
| 16 | 0,003810466 | 0,00281916 | 1,35162975 | 9125444,4 | 312497,4 | 8812947 | VRAI |
| 67 | 0,002954582 | 0,00052 | 5,68193497 | 7075741 | 260445,8 | 6815295,2 | VRAI |
| 56 | 0,002505746 | 0,00150219 | 1,66805878 | 6000853,4 | 1303733,2 | 4697120,2 | VRAI |
| 59 | 0,003095089 | 0,00139768 | 2,21444736 | 7412233,6 | 1695077,2 | 5717156,4 | VRAI |
| 58 | 0,001988971 | 0,00067658 | 2,9397322 | 4763261,4 | 472053,6 | 4291207,8 | VRAI |
| 65 | 0,001855581 | 0,00054745 | 3,38948558 | 4443813,4 | 112360,4 | 4331453 | VRAI |
| 43 | 0,00165412 | 0,00046748 | 3,53839711 | 3961348,4 | 1014206,4 | 2947142 | VRAI |
| 57 | 0,001178296 | 0,00088114 | 1,33724559 | 2821826,6 | 121087,4 | 2700739,2 | VRAI |
| 66 | 0,001115364 | 0,00019624 | 5,68375486 | 2671113,8 | 16451,4 | 2654662,4 | VRAI |
| 92 | 0,000702595 | 0,00037411 | 1,87806235 | 1682600,8 | 448135,2 | 1234465,6 | VRAI |
| 5 | 0,00090495 | 0,00057389 | 1,57686391 | 2167207,6 | 696598 | 1470609,6 | VRAI |
| 46 | 0,000660046 | 0,00014098 | 4,6817338 | 1580702,4 | 15553,8 | 1565148,6 | VRAI |
| 13 | 0,000612694 | 0,00042812 | 1,43113212 | 1467302,4 | 313421,8 | 1153880,6 | VRAI |
| 36 | 0,000356448 | 0,00023864 | 1,49368163 | 853636 | 137939,2 | 715696,8 | VRAI |
| 50 | 0,000410966 | 0,00010899 | 3,77051787 | 984197,2 | 53172,8 | 931024,4 | VRAI |

*Source: Trade Maps ITC and Own calculations*

The table groups the different manipulations necessary for the calculation of the RCA of China for the different SH2 categories of products.

The column "code" corresponds to the aggregation of products whose nomenclature begins with the same two first digits (SH2).

The second column is the ratio of exports of the product from China to the rest of the world on the world exports of the corresponding product.

The third column is the ratio of China's total exports to the rest of the world to the rest of the world's exports.

The fourth column is the ratio of the previous two. This is Balassa's Revealed Comparative advantage index. The RCA value of a product measures China's export specialization, which in turn is an indication of the strength of Chinese production of that product.

The fifth column is the average exports of the product over the year 2016 to 2020. While the Sixth is the imports for this period. The seventh is the difference between these two columns. When the value is positive it means that the country exports more than it imports the product.

The last column is an Excel function to select the goods for which the trade surplus column is positive and RCA positive.

Imports from countries where there is a comparative advantage must be taken into account. It is rather strange to say that a country has a comparative advantage in a commodity that it must import more than it can export. Therefore, it is suggested here that adding the following selection criteria may filter out some false positive export opportunities. We subtract imports from exports of goods in which China has a comparative advantage (Balassa, 1965).

Calculations can be performed on more precise product categories. That is to say on categories of nomenclature to 6 digits (see table 1 and 2 of the work)

*Source: Balassa, 1965*

## Appendix H

**China's ULC and RULC relative to the U.S.**

So, we see an increase in wages in China, but what about the change in productivity? Based on the Ricardian model, Dornbusch, Fischer and Samuelson developed a condensed version of the model. Under the same assumption as in the Ricardian model, we can calculate the unit labor cost (ULC) of a country and the relative unit labor costs between two or more countries (RULC). Both focus on labor costs and productivity.

> **Unit Labor Cost**: The ULC is a measure of China's level of competitiveness. It can be calculated as the ratio of the average annual wage multiplied by the number of workers to the total value added for a specific sector.
>
> **Relative Unit Labor Cost**: The RUCL is the ratio between the ULC of each country expressed in the same currency unit.

We will therefore measure the ULC of China and the RULC of China vis-à-vis the United States for the industrial sector. It allows us to easily compare two countries. Both indices do not consider the cost of human capital, energy, human capital, and infrastructure. But this is a limited issue because they influence labor productivity and are indirectly reflected in the UCL and RUCL (Dornbusch, Fischer and Samuelson, 1977).

**The model**:

Mathematically, the calculation of the unit labor cost can be broken down into two parts. First, the unit labor requirement (the inverse of productivity) for sector *i* is calculated.

(1) $a_i = L_i / Q_i$

$Q_i$ is the value-added of sector *i* and $L_i$ is the number of workers in sector *i*. Then we multiply ai, the unit labor requirement with the annual average wage of sector *i* to obtain the unit labor cost.

Unfortunately, the lack of Chinese data does not allow us to obtain the annual average wage for the industrial sector. Therefore, we will replace the annual industrial wage with the annual manufacturing wage. We will perform the same calculations with the average wages of the Chinese economy to ensure the validity of the calculations.

Finally, the calculation of the RUCL is done using the exchange rate which allows us to express the two UCLs in the same currency unit. The home country has a competitive advantage for good *i* when $RULC_i < 1$.

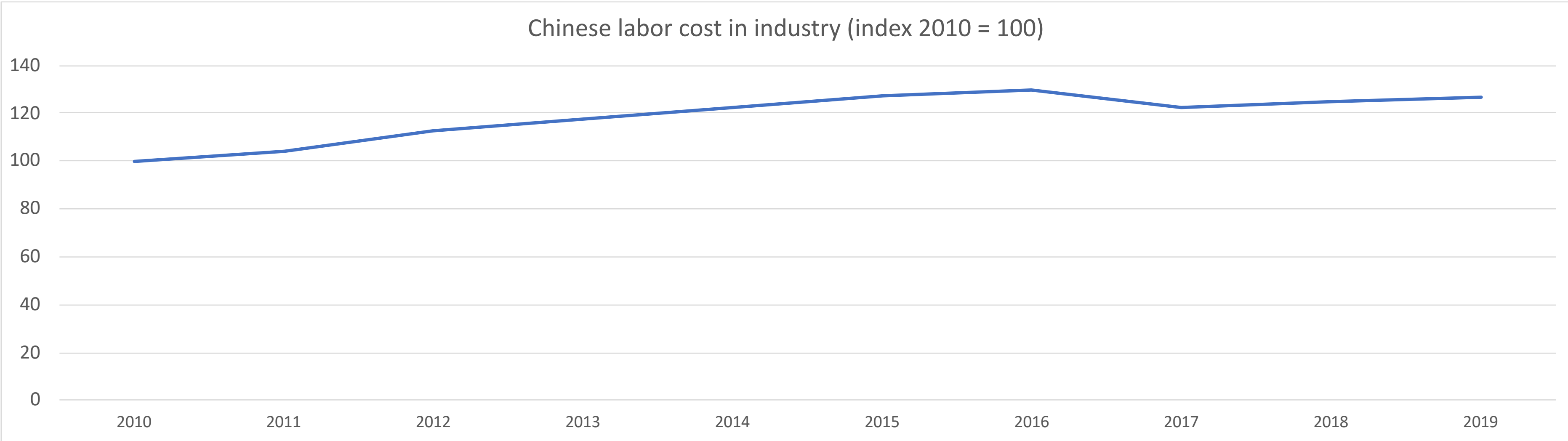
$RULC_i = (a_i * w_i) / (a_i * w_i * e)$

**China's ULC:**

Because we do not have access to average wages in the industrial sector. We measure with two types of data: the annual average labor cost in the manufacturing sector and the labor cost of the global economy in China. The results are closed and show the same movement.

We begin the analysis with the Chinese ULCs. The following figure describes Chinese labor costs measured in US$ and indexed to 2010. Overall, over the period analyzed, ULCs have increased. This reflects a stronger increase in average wages relative to productivity. Indeed, productivity in US$ increases by 89.74% while wages increase by 149.46% for the period analyzed.

| China and wage from manufacturing sector | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Wage in Manufacturing (yuan) | 30700 | 36665 | 41650 | 46431 | 51369 | 55324 | 59470 | 64452 | 72088 | 78147 | 82783 |
| Exchange rate Yuan | 6,770269029 | 6,461461327 | 6,312332827 | 6,195758346 | 6,143434094 | 6,227488673 | 6,644477829 | 6,758755086 | 6,615957177 | 6,90838501 | 6,9007673 |
| Average Wage in Manufacturing (US$) | 4534,53177 | 5674,412977 | 6598,194541 | 7493,997894 | 8361,610007 | 8883,837917 | 8950,289477 | 9536,075679 | 10896,0802 | 11311,90573 | 11996,202 |
| Industry (including construction), value added per worker for China (constant 2010 US$) | 13319,03944 | 14287,9064 | 15037,12407 | 16297,66313 | 17539,61539 | 19010,3386 | 20383,43964 | 22083,63013 | 23200,41209 | 25271,87652 | |
| Industry (including construction), value added (constant 2010 US$) | 2,8304E+12 | 3,13293E+12 | 3,39496E+12 | 3,66612E+12 | 3,92845E+12 | 4,16128E+12 | 4,41227E+12 | 4,67119E+12 | 4,94177E+12 | 5,18266E+12 | 5,317E+12 |
| Industry (including construction), value added (current US$) | 2,8304E+12 | 3,51366E+12 | 3,87559E+12 | 4,22789E+12 | 4,51351E+12 | 4,51769E+12 | 4,4462E+12 | 4,90591E+12 | 5,51444E+12 | 5,51026E+12 | 5,568E+12 |
| Total Labor Force | 783880000 | 785790000 | 788940000 | 793000000 | 796900000 | 800910000 | 806940000 | 806860000 | 805670000 | 811040000 | |
| Employment in industry (% of total employment) (modeled ILO estimate) | 28,70 | 29,50 | 30,30 | 30,10 | 29,90 | 29,18 | 28,80 | 28,11 | 28,32 | 27,42 | |
| Employment in industry in China | 224 973 565,98 | 231 808 050,00 | 239 048 813,98 | 238 693 003,03 | 238 273 096,96 | 233 705 540,44 | 232 398 713,84 | 226 808 350,92 | 228 165 741,54 | 222 387 168,62 | - |
| Unit labor requirement in US$ (inverse of produtivity) | 0,00007948472512 | 0,00006597338672 | 0,00006168062514 | 0,00005645676757 | 0,00005279108653 | 0,00005173120343 | 0,00005226906433 | 0,00004623165752 | 0,00004137604934 | 0,00004035874326 | - |
| Unit labor costs China in US$ | 0,36042601126277 | 0,37436024175075 | 0,40698076408490 | 0,42308689726727 | 0,44141847738668 | 0,45957162655759 | 0,46782325650782 | 0,44086858484487 | 0,45083675197860 | 0,45653429922683 | # |
| Unit labor costs China in US$ indexed to 2010 | 100 | 103,8660446 | 112,9165907 | 117,3852286 | 122,4713155 | 127,5078968 | 129,797307 | 122,3187481 | 125,0844106 | 126,665192 | 0 |



We observe a tree sub-period, between 2010 and 2016, the ULC increases as the average cost increases sharply compared to productivity (97% against 53%). The same conclusion for the period 2017-2019 while the salary increases by 18.62% and productivity by 14.44%. The second sub-period is 2016-2017 where productivity increases more than salary, 8% against 7% in domestic currency.

Our conclusion is the same than Hanson 2020. He calculates China's share of world exports and the logarithm of the revealed comparative advantage (RCA) for the ten labor-intensive products over the period 1984-2018. China’s share of world exports increased between 1984 and 2001 by 17.1%. After its introduction into the WTO, the share increased to 16.5%. However, the share fell to a level of 31.6 in 2018.

Figure 1: China Exports in Labor-Intensive Manufacturing


Regarding China's identified comparative advantage in labor-intensive goods, it peaked in 1992 with an RCA value of 142 log points. After that, it only decreased to 90 log points in 2018. Both indicators point to the fact that China is losing its comparative advantage in manufacturing or labor-intensive goods.

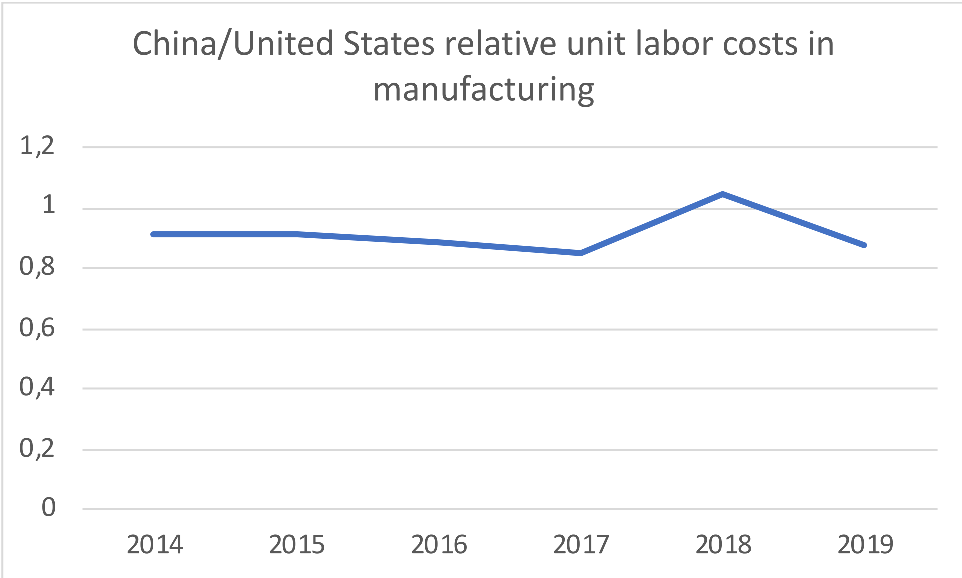
The fear of investors regarding the increase in wages certainly has its source in the increase of the ULC but let's see if this is a reason to leave the Chinese market thanks to the analysis of RULC.

**China's RULC relative to the U.S.:**

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit labor costs China in US$ | r | 0,374360242 | 0,406980764 | 0,423086897 | 0,441418477 | 0,459571627 | 0,46782326 | 0,44086858 | 0,45083675 | 0,4565343 | 0 |
| Unit labor costs US in US$ | | | | | 0,485527719 | 0,504003005 | 0,52793855 | 0,519751 | 0,43051816 | 0,52279455 | #DIV/0! |
| RULC | #VALEUR! | #DIV/0! | #DIV/0! | #DIV/0! | 0,90915196 | 0,911843028 | 0,88613202 | 0,84823037 | 1,04719567 | 0,87325757 | #DIV/0! |
| | | | | | | | | | | | |
| Industry (including construction), value added per worker for China (constant 2010 US | 13319,03944 | 14287,9064 | 15037,12407 | 16297,66313 | 17539,61539 | 19010,3386 | 20383,4396 | 22083,6301 | 23200,4121 | 25271,8765 | |
| Industry (including construction), value added per worker for US (constant 2010 US$) | 104192,035 | 103447,1 | 102801,232 | 103419,29 | 103814,399 | 105442,995 | 104443,013 | 105580,497 | 107423,128 | 108265,396 | |
| Relative value added per person | 12,783% | 13,812% | 14,627% | 15,759% | 16,895% | 18,029% | 19,516% | 20,916% | 21,597% | 23,343% | |
| | | | | | | | | | | | |
| Average Wage in Manufacturing for China (US$) | 4534,53177 | 5674,412977 | 6598,194541 | 7493,997894 | 8361,610007 | 8883,837917 | 8950,28948 | 9536,07568 | 10896,0802 | 11311,9057 | 11996,2023 |
| Average Wage in Manufacturing for US (US$) | | | | | 56264,19002 | 57663,99244 | 59351,7045 | 61277,3372 | 53122,5919 | 64861,2807 | |
| relative labor compensation per person | | | | | 14,9% | 15,4% | 15,1% | 15,6% | 20,5% | 17,4% | |

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| relative labor compensation per person | 14,86% | 15,41% | 15,08% | 15,56% | 20,51% | 17,44% |
| Relative value added per person | 16,90% | 18,03% | 19,52% | 20,92% | 21,60% | 23,34% |
| RULC | 90,92% | 91,18% | 88,61% | 84,82% | 104,72% | 87,33% |

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Price Industry China (index 2017) | 100 | 103,5 | 102,9901 |
| Price Industry US (index 2017) | 100 | 103,1809 | 102,3428 |
| PPP exchange rate | 1 | 1,003092627 | 1,006324822 |



The following figure represents the relationship between China's RULC expressed in US$. In general, the RULC remains stable over time. Productivity increases more strongly than wages in China, 44.08% versus 35.28%. In the U.S., the opposite is true, with wages increasing more strongly than productivity, 15% versus 4%. We observe a peak in 2018.

The measure shows that China's unit industrial labor costs increased from 84.82 % to 104.72 % of U.S. unit labor costs between 2017 and 2018. It can be explained by the decrease in the U.S. unit labor cost. Indeed, productivity increases in the 2 countries, but the average wage increases in China while that of the United States decreases by 13% in 2017-2018.

We observe a decrease in China's RULC from 104.72 % to 87.33 % between 2018 and 2019. RULC returns to its initial value. The average wage increases more rapidly in the United States compared to China, decreasing China's RUCL.

**China's competitive position :**

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| relative labor compensation per person | 14,86% | 15,41% | 15,08% | 15,56% | 20,51% | 17,44% |
| Relative value added per person | 16,90% | 18,03% | 19,52% | 20,92% | 21,60% | 23,34% |
| RULC | 90,92% | 91,18% | 88,61% | 84,82% | 104,72% | 87,33% |

The table above compares China's levels of industrial productivity, labor compensation, and unit labor costs with their U.S. counterparts for the period 2014-2019. Both measures show that China's relative labor compensation and productivity levels have increased sharply over the decade. Between 2018 and 2019, relative wages decline, and relative value-added continues to grow. But they remain small fractions of US levels.

China remains competitive with the U.S. industry, with a RUCL equal to 87.33%. The home country has a competitive advantage when RULC is less than 1, meaning its unit labor costs are lower than those of its trading partners. The unit labor costs between the two countries are similar over time. This is again what conclude Hanson. China's share of world exports and the logarithm of the revealed comparative advantage (RCA) for the ten labor-intensive products over the period 1984-2018 remain very high compared to other countries around the world. The author also calculated the same indicators for other countries such as Poland, Turkey, Asian countries, ... (Hanson 2020)

There is a decline in China's exports in the labor-intensive manufacturing sector. This is due to the slowdown in Chinese economic growth.

*Source: Hanson 2020 and own calculations*

# Appendix I

**The Melitz model (2003)**

To understand Melitz's model, one must understand Krugman's new trade model.

Krugman Model

The Krugman model assumes that consumers love varieties. There are many imperfectly substitutable varieties, indexed by i. The utility function is:

$$U= \sum_i c_i^{\frac{\sigma-1}{\sigma}\frac{\sigma}{\sigma-1}} \quad \sigma>1$$

Each firm has a monopoly on its own variety (i indexes both varieties and firms).
Denote individual consumption as $ci$ and aggregate consumption as $qi= Lci$.
Firms use only labor and the wage cost is 1 to simplify. So, the labor requirement and cost function are:

$$l_i = aq_i + f$$

F is the fixed cost due to increasing return to scale associated with production. A is the marginal productivity and $q_i$is the quantity produced. In the Krugman mode, we assume that a is the same for the firms. But later in the Melitz model, we will assume that productivity between firms is no longer the same.

Because we are in the case of increasing return to scale, $\frac{l_i}{q_i} = a + \frac{f}{Lc_i}$

The profit function is given by $\pi_i = p_i q_i - aq_i - f$

A individual producer sells P$ for each unity no matter the level of production, so marginal revenue is equal to P. Average revenue= R(q)/q = Pq/q=P. for a competitive firm, Average revenue = marginal revenue. The profit is maximized when P = MR = mR =mC

The optimal price level is $p_i = a\frac{\sigma}{\sigma-1}$.

Prices are the same for all goods (symmetry). The price does not depend on output (the property of the utility function)

Given the price and because of free entry, firms profits are equal to zero in the equilibrium. Therefore, $\pi_i$ =0

$$p_i = a + \frac{f}{Lc_i}$$

The number of firms on the market (N) is determined by the labor market equilibrium: $L = N(aLc + f)$

It is easy to show that: $q = \frac{(\sigma-1)f}{a}$ $and\ N = \frac{L}{f\sigma}$

<u>The Melitz Model</u>

Based on Krugman model where all the firms are symmetric: All firms export and are of the same size in equilibrium. There isn't heterogeneity between firms.

There are two countries, Home and Foreign which are symmetric.
As in Krugman, each firm has a monopoly on its variety and produces using a technology with increasing returns. But now the productivity between firms is no longer the same. Each firm producing a specific good has different productivity level ai
Difference with Krugman: $l_i = a_i q_i + f$ $L=1$

When a firm decides to sell in the foreign market, it needs to pay 2 types of costs:

A variable cost of trade $\tau \geq 1$. $\tau$ units of a good must be shipped for one unit to arrive at destination abroad.
A fixed cost of trade: $f_x$

Each firms maximize profits on the Home and Foreign market independently. $p_i = \frac{\sigma}{\sigma-1} a_i$ $\sigma>1$

As in Krugman, firms charge a constant markup over marginal costs. But marginal costs differ between firms and between markets:

$p_i = \frac{\sigma}{\sigma-1} a_i$ on the domicile market
$p_i = \frac{\sigma}{\sigma-1} \tau a_i$ on the foreign market

If a firm sells on the domestic market, its profits there are:

$$\pi_{di} = p_i q_i - a_i q_i - f_x$$

Plugging in the solution for $pi$ shows that (B is a constant):

$$\pi_{di} = B a_i^{1-\sigma} - f$$

If a firm sells on the foreign market, its profits there are:

$$\pi_{xi} = p_i q_i - \tau a_i q_i - f_x$$

Plugging in the solution for $pi$ shows that:

$$\pi_{xi} = B(\tau a_i)^{1-\sigma} - f_x$$

- *The non-exporting firms*

The demand function for firm j's product is $x(j) = Ap(j)^{-\varepsilon}$, where *x* is quantity and *p* is price. *A* is a measure of the level of demand and $\varepsilon \equiv 1/(1 - \alpha)$ is the elasticity of demand. To simplify the analysis, the elasticity of demand is constant and greater than 1 when $0<\alpha<1$.

$cf_D$ is the fixed cost where c measures the cost of resources (this is the wage rate when there is only labor); and $f_D$ is a measure of fixed production costs in terms of resources. The total fixed cost is then $cf_D$.

$c/\theta(j)$ is the variable production cost per unit of output.

Then, if the firm chooses to sell the product, its profit maximization strategy is to charge $p(j) = c/\alpha\theta(j)$[1]. This gives the following profile formula: $\pi(j) = \theta(j)^{\varepsilon-1}B - cf_D$ where $B = (1-\alpha)A(c/\alpha)^{1-\varepsilon}$.

The formula below plots the firm's profits against the productivity measure $\Theta\equiv\theta^{\varepsilon-1}$. The function is visible in the figure 1.

$$\pi_D(\Theta) = \Theta B - cf_D$$

- The *exporting* firms

The firm may choose to export its output to country ℓ. To do so, it faces fixed export costs, $cf_X$. Moreover, there are iceberg exchange costs to ship each brand of the product from its country to ℓ, so $\tau > 1$ unit must be shipped for one unit to arrive. In this case, the export price is equal to p multiplied by $\tau$. Moreover, $A^{\ell}$ is the level of demand in the home market and is not necessarily the same as A. Under these conditions, a firm that chooses to sell in the home market, i.e., a firm with productivity $\Theta > \Theta_D$, can earn additional profits by exporting.

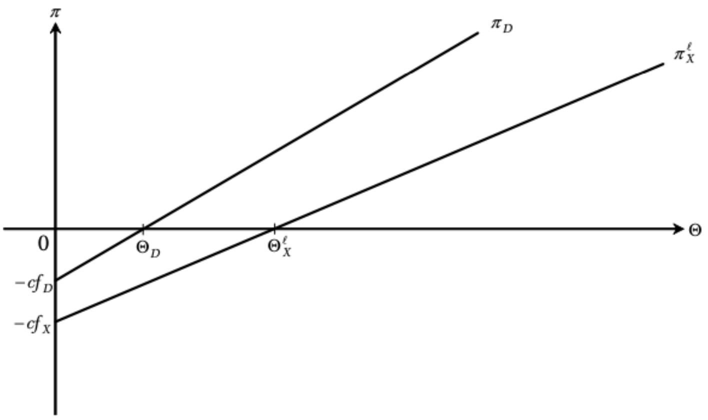
$$\pi_X^{\ell}(\Theta) = \tau^{1-\varepsilon}\Theta B^{\ell} - cf_X$$

The following graph describes the profit on the vertical axis and the productivity level on the horizontal axis. The left-hand function describes the profit of a firm that decides to sell its products within its territory. The second function describes the profit if the firm decides to

[1] Labor requirement: $li = \frac{x_i}{\theta} + f$

Free entry implies that marginal cost, $MC = \frac{l_i}{x_i}$, is equal to price export its output to country ℓ. The figure depicts both $\pi_D(\Theta)$ and $\pi_X^{\ell}\Theta$, for the case where $A^{\ell} = A$ (so $B^{\ell} = B$) and $\tau^{\varepsilon -1} f_X > f_D$.

**Graph n°1: Exporting and Non-exporting Firms**




Firms with too low a level of productivity choose not to produce because, for these firms, variable profits do not cover their fixed cost, while firms with higher productivity supply their brands to the market.

Firms with a productivity level between $\Theta_D$ and $\Theta_X^{\ell}$ choose to sell in the domestic market because their profit is higher in this situation. Once productivity is higher than $\Theta_X$, the firm enjoys a higher profit by also exporting its output.

- The FDI-firms

Horizontal foreign direct investment can be included in the Melitz model. There are two types of FDI:

**Horizontal FDI** are subsidiaries of a multinational firm that serve the local market in the host country.
**Vertical FDI** are subsidiaries that add value to products that are not (necessarily) destined for the host country market.

It is assumed that a firm can choose to manufacture a plant in country ℓ, at cost $cf_I$, which will allow it to produce its brand of product in the country at unit cost c/θ, where θ is the firm's productivity.

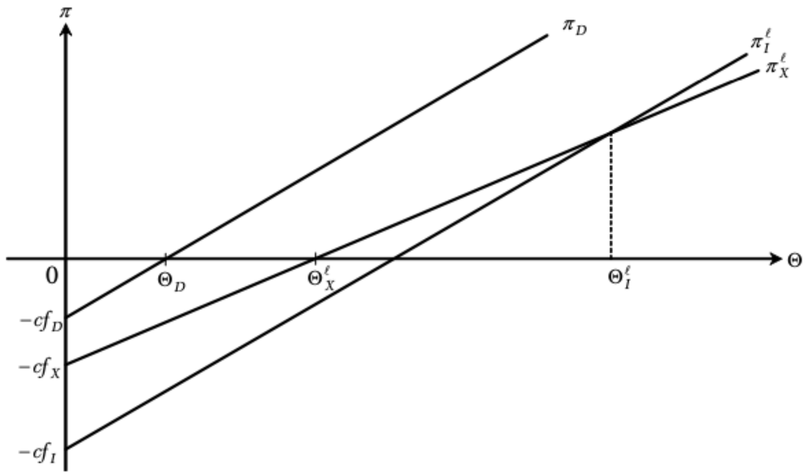
Then, if the firm chooses to serve the foreign market through FDI, the firm's profits from FDI are

$$\pi_I(\Theta) = \Theta B_I^{\ell} - cf_I$$

we note that, as long as $f_I > f_X$ and $c^\ell < c\tau$, the firm faces a trade-off between proximity or concentration. That is to say that by practicing FDI, the firm implements a strategy of proximity and renounces the concentration of production. That makes him save the variable costs but increase the fixed costs (Brainard, 1997).

The figure below describes this arbitration for the case where $c^\ell = c$, $B_I^\ell = B^\ell$ (i.e. the level of demand is the same in both countries), and $f_I > \tau^{\varepsilon-1} f_X > f_D$. Under these conditions, $\Theta_I^\ell > \Theta_X^\ell > \Theta_D$. It follows that the most productive enterprises, with $\Theta > \Theta_I^\ell$, serve the foreign market through subsidiaries and thus practice FDI.

**Graph n°2: Multinationals, Exporting, and Non-exporting Firms**




Under all circumstances, $\Theta_I > \Theta_X > \Theta_D$. It follows that the most productive firms, with $\Theta > \Theta_I$, serve the foreign market via subsidiaries; less productive firms, with $\Theta_X < \Theta < \Theta_I$, serve the foreign market via exports; and even lower productivity firms, with $\Theta_D < \Theta < \Theta_X$, serve only the domestic market.

*Source: Helpman 2006*

# Appendix J

**Melitz Deep Model**

The model studied in this section is a deepening of Melitz's previous model that incorporates the contractual frictions between the supplier and the producer of the final good of Antràs and Helpman (2004). At the end of the explanation, we will explain that firms whose production is headquarters intensive and sufficiently productive prefer to practice vertical FDI.

## 1) The relationship between the producer and the supplier

We assume that the demand function is the same as in the classical model of Melitz (2003), $x(j) = Ap(j)^{-\varepsilon}$, $\varepsilon = 1/(1 - \alpha)>0$

The model assumes two inputs: headquarters, h(j), and components, m(j). These intermediate inputs are combined via a Cobb-Douglas production function to produce either brand j of the differentiated product, x(j), or another intermediate input of type j, for example y(j), which is used to assemble x(j).

The producers of final goods are in the North where they also produce the services of the head office h. The component h can only be produced in North. While the components are produced by external firms (Antràs and Helpman, 2004). The production function of the final and intermediate good is as follows:

$$z(j) = \Theta(\frac{h(j)}{\eta})^{\eta} (\frac{m(j)}{1-\eta})^{1-\eta}$$

z is either x or y, θ represents productivity, and η measures contract input intensity. Productivity varies across firms. The wage rate is higher in the North ($w^N > w^S$). m can be produced in the South or in the North. In both countries, the labor input per unit of output is the same. The form of organization does not achieve the same entry cost: $f_V^S > f_O^S > f_V^N > f_O^N$. the fixed costs of integration in the South are higher than outsourcing in the South and the same for the North. Variable costs are lower in the South.

When we combine the final demand functions, $x(j) = Ap(j)^{-\varepsilon}$ and the production function, z(j), we obtain the final income from the production of the total income, R[h(j) ; m(j)][2].
The final good producer and the supplier cannot negotiate their surplus production to be exchanged between them. The producer of the final good chooses the quantity of h(j) to produce and the distributor of the intermediate component chooses m(j). The producer of the final good chooses from a wide range of distributors to produce m(j). Thus, when the

[2] $R(i) = X^{\mu-\alpha}\theta^{\alpha}(\frac{h}{\eta})^{\alpha\eta}(\frac{m}{1-\eta})^{\alpha(1-\eta)}$

supplier market is in equilibrium, the zero-profit condition applies and the total net revenue is equal to the opportunity cost of the distributors[3].

Nevertheless, in order for the production of the final good to take place, the negotiation between the two parties must succeed. It is assumed that the firms enter into bargaining after producing their respective h and m. Thus, the final producer will get β of the revenue, R, and the distributor, (1-β).

The final producer's choice of organization depends on comparing the optimal profit distribution. Indeed, the producer will maximize his profit by choosing β*. This share is between 0 and 1. But β* cannot correspond to 1 since the distributor has no incentive to produce m because this component is not part of the production of the final good.

### 2) Outsourcing:

In outsourcing, there are two firms; both produce an input. There are no outside options available for both parties. That is, the final good firms produce the input h and the supplier produces the intermediate input, m. When the supplier is an autonomous firm, if the parties cannot agree on the distribution of the surplus, the domestic good producer has nothing. When the bargaining succeeds, each of the inputs is used in the production of the final good, z(j). Thus, the producer of the final good receives the fraction β of the revenue, while the supplier receives the fraction 1 - β.

### 3) Internalization:

For internalization, the supplier is the employee of the firm that produces the final good. Nevertheless, for production to take place, the bargaining between the two parties must also be respected. Otherwise, the firm of the final good can only produce a fraction δ of the output in z(j).

The supplier has no external option at the bargaining stage, while the final good producer's external option is a fraction δα of the revenue R[h(j), m(j)]. In the case of integration, the producer of final goods can go after the manager of the supplier division and take some quantity of produced inputs when the negotiation is not successful. In particular, the final goods producer only gets the residual rights to a fraction of δ between (0, 1) of the input.

The $\delta^{\alpha}$ represents the cost of firing the supplier. If it were equal to 0, the producer would have an incentive to have the supplier produce m and then fire him. Thus, there would be no m and output would be zero. Since this result is extraneous, it is assumed that there is a cost of firing the supplier. It results in a smaller share of revenue, $\delta^{\alpha}$.

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[3] This is also explained by the fact that the producer of the good imposes a participation fee in his profit. He has an incentive to keep t as high as possible until the supplier's profit is zero.

Thus, in the bargaining process, the producer of the final good receives his outside option and the quasi-rent. This corresponds to a fraction $\beta_V = \delta^\alpha + \beta(1 - \delta^\alpha)$ of the revenue R[h(j), m(j)].

The supplier receives a fraction $1 - \beta_V$ of R[h(j), m(j)].

It is also estimated that final goods producers are able to appropriate higher fractions of revenue under integration than under outsourcing, with this fraction being larger when integration occurs in the North.

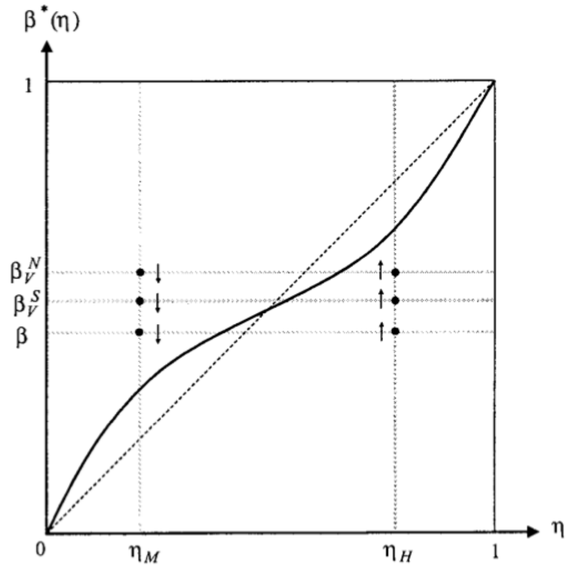
$$\beta_V^N = (\delta^N)^\alpha + \beta(1 - (\delta^N)^\alpha) \geq \beta_V^S$$
$$\beta_V^S = (\delta^S)^\alpha + \beta(1 - (\delta^S)^\alpha) > \beta_O^N = \beta_O^S = \beta$$

As in Grossman and Hart (1986), integration gives final good producer residual rights of control that allow it ex post to use the inputs produced by the supplier, which in turn enhances producer's bargaining position. As a result, producer gets a higher fraction of the revenue under integration.

### 4) Optimal bargaining share:

The choice of organizational structure depends on β which will provide it with the optimal revenue distribution, R[h(j), m(j)]. Let $\beta*$ be the most preferred share of the producer of the final good, which maximizes his profits. $\beta*$ is strictly positive and strictly lower than one. The form of the relationship between $\beta*$ and η is shown in the figure below. The intensity of the headquarters activity gives an advantage in the distribution of income for the producer since it produces this input.

**<u>Graph n°3: Optimal Bargaining share</u>**




The figure also shows the distribution of revenue shares in the outsourcing and integration cases, β and $\beta_V$, respectively. They are greater than the optimal $\beta*$ when an industry is component-intensive so that η is small (such as $\eta_M$). They are less than $\beta*$ when an industry is headquarters intensive so that η is large (such as $\eta_H$).

The arrows show the direction of profit growth. Profit increases as the producer's share of the final good shifts vertically to β∗. This characterization implies that there is a $\eta_c$ (not drawn in the figure) with $\eta_M < \eta_c < \eta_H$, such that the final good producer earns higher profits from outsourcing when η is less than $\eta_c$ and higher profits from integration when η is greater than $\eta_c$.

It follows that, based solely on the consideration of the power of incentives, final goods producers prefer outsourcing in component-intensive industries and integration in headquarters-intensive industries.

### 5) Analysis of trade and FDI flows

We will now calculate the profit function as in the previous simple Melitz model taking into account the new specificities such as the new fixed costs, the combination of the two components m and h.

Assume that there are different fixed costs of entry for each of the forms of organization: $f_V^S > f_O^S > f_V^N > f_O^N$. $f_V^S$ is the fixed cost of integration in the South (FDI), $f_O^S$ is the fixed cost of outsourcing to the South, $f_V^N$ is the fixed cost of integration in the North, and $f_O^N$ is the fixed cost of outsourcing to the North, all measured in terms of Northern labor.
We will also take into account the preferences of firms according to the type of sector (component-intensive or headquarter-intensive) and their characteristics (productive or not). in the choice of organization (integration or not, abroad or not).

### 6) Component-intensive industry:

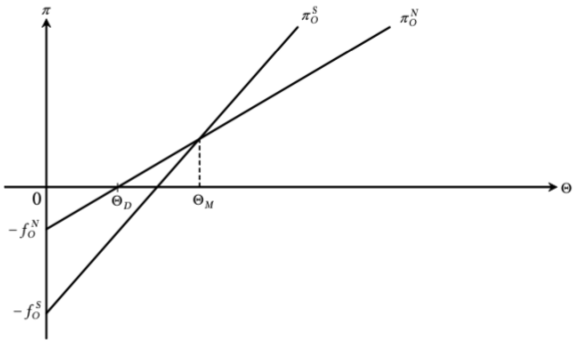
Firms with component-intensive production do not integrate; high-productivity firms outsource components to the South, low-productivity firms outsource to the North, and the least productive firms exit. Outsourcing is favored for component-intensive firms because:

- Its fixed cost is the lowest compared to foreign integration (FDI).
- Firms producing the final good prefer to outsource to a component-intensive sector.
- β is closer to β* than $\beta_V^S$ and $\beta_V^N$ and it is low ensuring a higher revenue fraction for the supplier. When the sector is component intensive, it provides an incentive for suppliers to produce m.

There are only two possible types of organization in component-intensive firms in the production of the final good: outsourcing to the south or to the north. We have already explained in the simple Melitz model that firms must be sufficiently productive to overcome the high costs of FDI. Nevertheless, they can benefit from lower marginal costs by producing abroad.

The trade-off in the choice of whether to relocate or not is between a lower variable cost in the South and a lower fixed cost in the North and is represented in the following figure:

***Graph n°* 4: Importing and Nonimporting Firms in a Component-Intensive Sector**

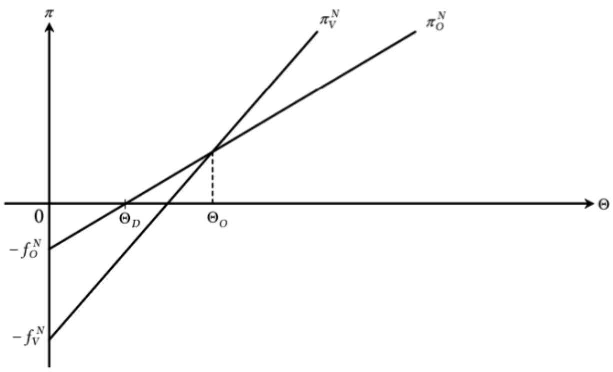



The following graph describes on the horizontal axis the variable Θ, the productivity of firms and the operating profits on the vertical axis. It appears that the operating profit function is linear in Θ and has the intercept at -f. It follows that the profit line $\pi_O^S$ figure 3 is steeper than the profit line $\pi_O^N$, because wages are lower in the South.

## 7) Headquarter-intensive industry:

A similar analysis shows that for headquarters-intensive firms, they have a choice between integration and outsourcing. This is shown in the following graph. $\pi_V^N$, represents the profits of an integrated producer and $\pi_O^N$ represents the profits of an outsourced producer. The $\pi_V^N$, profit line is steeper because integration in a headquarter-intensive industry provides better incentives for parts suppliers ($\beta_V^N$ is close to β* for the firm that produces the final good but lower than β*). As can be seen from the graph, the most productive firms can integrate while the least productive firms leave the external market and reserve only the internal market. Intermediaries may resort to subcontracting.

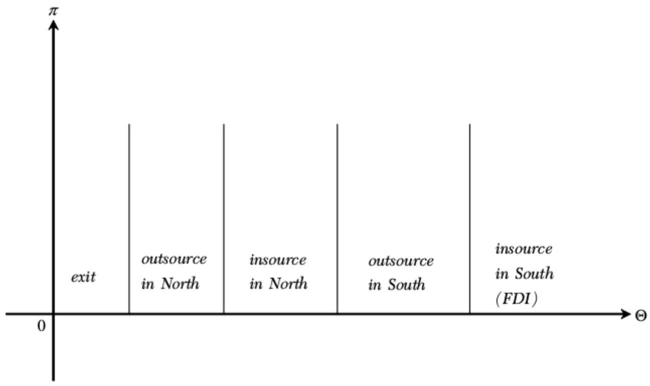
**Graph n°5: Insourcing and Outsourcing Firms in North in a Headquarter-Intensive Sector**



### 8) Sorting model in the headquarters-intensive industry:

Combining this analysis with a similar analysis of the trade-off between outsourcing and integration in the South, and taking into account that offshoring has a variable cost advantage but a fixed cost disadvantage, we obtain the sorting pattern depicted in Figure 6.

**Graph n°6: Sorting Pattern in a Headquarter-Intensive Sector**



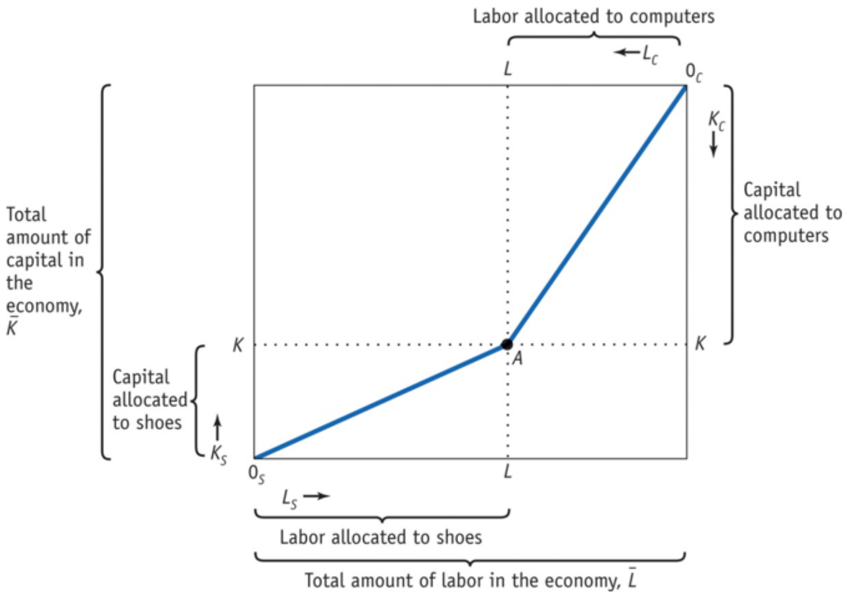

Among the headquarters-intensive firms, the least productive firms leave the industry. The most productive firms use FDI to produce intermediate inputs in the South. In between, the least productive firms outsource to the North, the most productive firms outsource to the South, and firms with intermediate levels of productivity integrate into the North.

*Source: Helpman, 2006*

# Appendix K

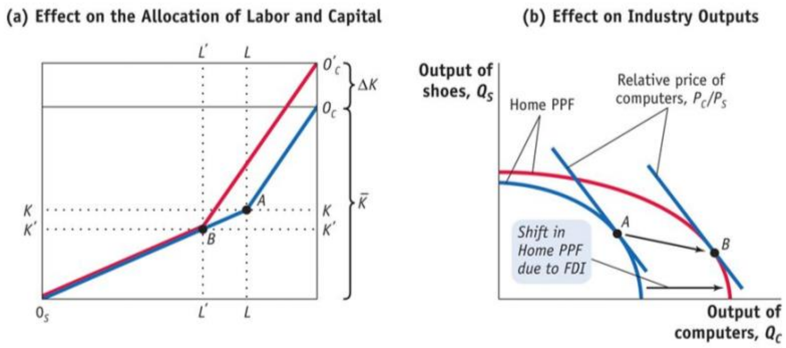
**the Heckscher-Ohlin model**

For this section, we will assume that there are 2 types of goods: the computer that requires more capital in its production and shoes that require more labor. $K_C/L_C > K_S/L_S$. Compared to the short run analysis, the HO model assumes factors are perfectly mobile. To understand what happens when capital increases through FDI, we will use a box plot that measures the amount of labor and capital for each sector. On the right axis we find the amount of capital for the shoe industry and on the left axis the capital for the computer industry. On the top and bottom axes, we find the workers in the computer industry and the shoe industry, respectively.




*Source: international trade Feenstra and Taylor, 2012*

The increase in capital extends the right and left sides of the box. Since there is no change in the labor-capital ratio for the sectors, the box describes a new allocation of resources: less labor and capital in the shoe industry and more labor and capital in the computer industry.




*Source: international trade Feenstra and Taylor, 2012*

The theorem is consistent with Rybcynscki's theorem that states that an increase in capital through FDI increases the output of capital-intensive industry and decreases the output of non-capital-intensive goods. But the wage and rental rate does not change because the capital-labor ratio does not change. This last reasoning explains the tilting of the $O_c$ - A curve to the right. (Feenstra, advanced trade)

The factor model predicts that in the short run, the increase in FDI leads to an increase in the wage, a decrease in the rental of agriculture and the rental of capital due to the decrease in marginal productivity in both sectors. In the long run, wages and rents are assumed to be fixed, but the production of capital-intensive goods increases while the others decrease.

# Appendix L

**Claro's model (2009)**

- *The basic assumptions of the model*

The international economy consists of two goods: x, which is capital intensive, and z, which is labor-intensive. The prices of the goods are set internationally. The two goods are produced with constant returns to scale production function. A constant return to scale function is when an increase in input results in a proportional increase in output. Production requires two factors of production: L, labor, and K, capital (they are immobile between countries).

$p_i^*=a_{Li} \cdot w + a_{Ki} \cdot r$ for i = x, z

$a_{Lz}$ for instance is the requirement of factor L to produce one unit of z. This equation corresponds to a nonprofit condition where the price is equal to marginal cost. The two equilibrium conditions of zero profits (for good x et z) determine domestic factor prices and factor intensity. Both goods are produced in autarkic equilibrium if $k_x(w/r) > k > k_z(w/r)$, where $k_i(w/r) = a_{Ki}/a_{Li}$. k is the relative factor endowment, K/L. home is labor abundant in this situation.

Suppose that the economy is composed of the home country and another country that represents the rest of the world. The rest of the world produces both goods. The home country is technologically backward. The difference in productivity between the 2 countries can be explained by differences in relative factor prices. This leads to differences in average factor productivity. The differences in average factor productivity are:

$a_{Li} / a_{Li}^* =(1+\delta)\cdot l_i(q)$ and $a_{Ki} / a_{Ki}^* = (1+\delta)\cdot k_i(q)$

$l_i(q)$ et $k_i(q)$ represent the effects of the relative price ratio of the factors $q = (w/r)/(w^*/r^*)$, on average factor productivity. This difference in productivity justifies the willingness of foreign firms to invest in certain countries like China. In his paper, S. Claro assumes that $l_x(1) = l_z(1) = 1$. Because productivity differences are the same across sectors, then q=1and factor price differences are given by:

$w_a/w^* = r_a/r^* = 1/(1+\delta) <1$ (a is autarky)

If the countries have the same preference. The trade pattern is the same as in the Heckscher-Ohlin model. The capital abundant country exports the good intensive in capital in its production while the opposite happens for the labor-abundant country.

Foreign firms want to move foreign capital into the home country. This foreign capital keeps its more advanced technology even abroad. Although the r* is higher than the home country r, foreign firms believe they have a higher return on capital because of the cheaper labor.

Foreign firms can only access local labor. Foreign capital is not reserved for them. This allows less productive firms to survive. Less productive Chinese firms have easy access to the credit market. This seems consistent with the low-productivity state-owned firms that have better access to credit market (Zhao, 2001).

Because of decreasing average cost of foreign firms' production, Foreign capital will enter the domestic country in sector x and/or z as long as:

$p_i^* \geq a_{Li}^* w + a_{Ki}^* r^* + F_i / q_i^*$
where, $q_i^* = K_i^*/a_{Ki}^* = L_i^*/a_{Li}^*$
$F_i$ is a fixed cost that compensates for the attractiveness of low domestic wages for technologically advanced foreign capital. it includes a series of elements that make the introduction of a foreign company in a foreign country costly (for example: lack of market knowledge, installation of infrastructures, ...). It is expressed in units of the good x and is specific to the enterprise and the foreign production sector.

where w is the post-integration real domestic wage rate and $q_i^* = K_i^*/a_{Ki}^* = L_i^*/a_{Li}^*$ is the level of output of the foreign producer in the industry i in the host country. $K_i^*$ is the amount of foreign capital in industry i, and $L_i^*$ is the level of employment of foreign firms in industry i. We assume that the foreign economy is suffocating so that capital outflows integrated in FDI flows do not affect factor prices in the country of origin.

- *Foreign firms 'minimum labor requirement*

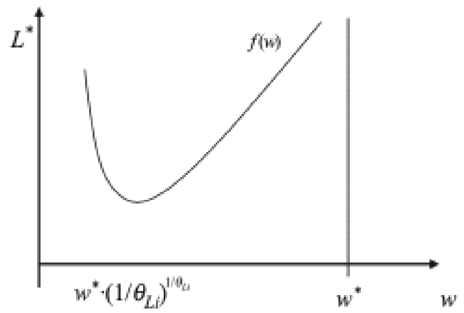
The marginal unit of foreign capital must be indifferent as to whether the good is produced abroad or in the domestic country. This means that the equation $p_i^*$determines the minimum output of the foreign firm in industry i with the zero profit condition.

To find the minimum level of employment from the $p_i^*$ function, we assume Cobb-Douglas function, $x = AL^{1-\alpha} K^{\alpha}$ and $z = AL^{1-\beta} K^{\beta}$ ($\alpha > \beta$). A is the total factor productivity of the home country and A* is that of the foreign country. $A^* = (1+\delta)A$. We impose legality on the $p_i^*$ function. We replace x and z in $q_i$. Then $q_i$ in the equation $p_i^*$. Finally, we isolate $L_i^*$.

$$L_i^* = \frac{\theta_{Li} F_i}{w^{1-\theta_{Li}} \cdot (w^{*\theta_{Li}} - w^{\theta_{Li}}}$$

$\theta_{Li}$ is the share of the labor force in industry i.
the relationship between $L_i^*$ and the household wage is U-shaped.

**Graph n°8: <u>Foreign Firms' Minimum Labor Requirement</u>**




when home wages are very low, the foreign firm has an incentive to use a labor-intensive production technique. This means that it hires many workers and Li* is large.
The foreign firm has an incentive to use a capital-intensive production technique and Li* decreases.
When the domestic wage increases, it increases the scale of production needed to compensate for $F_i$. The foreign firm must produce more and hire workers (As a reminder, $L_i$* is the minimum level of hiring in the foreign country and thus, of production).

The interesting part is the the upward segment of fi(w). As foreign firms in labor-intensive industries benefit more from low wages, and are therefore able to offer higher wages for the same level of employment. Therefore, if $F_z = F_x$, then $f_z(w) < f_x(w)$.

- *Residual domestic labor supply*

In our economy, there is a second equilibrium that must be analyzed. This is the residual supply of domestic labor available for foreign production.

We always assume that the capital market is segmented, so the level of employment of domestic firms, which is a function of wages, can be determined via the capital market equilibrium (this is the reasoning we have in the section: Foreign firms 'minimum labor requirement). The level of employment of domestic firms is consistent with the optimal use of factors by domestic producers.

The residual supply of domestic labor for foreign production is the difference between the total supply of labor (assumed to be totally inelastic) and the employment of domestic firms. Foreign investment and employment are constrained by the level of domestic employment consistent with the domestic capital market equilibrium, which depends on the domestic wage rate. There are two possible scenarios:

1) **$W>W_a$**: When the wage is higher than that offered by domestic firms in autarky. The labor-intensive sector becomes uncompetitive. All capital goes into the capital-intensive industry.

For each w there is a unique level of employment of domestic producers for a clean capital market.

The need for domestic factor in industry x is:

$a_{Kx} / a_{Lx} = K / (L–L^*)$

K and L are the employment and domestic capital and L* is the level of domestic employment by the foreign producer.

As w increases, domestic firms tend to go into the production of the capital-intensive good, x. This increases the quantity of workers available to the foreign producer. This increases the quantity of workers available to foreigners.

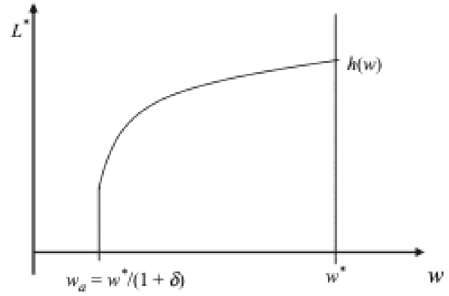
Recall that the return on national capital is determined endogenously, which means that a higher national wage rate leads to a lower return on capital and a lower rent-to-wage ratio. For the Cobb-Douglas specification described above, h(w) is given by:

$$h(w) = L.(1 - k.(\frac{A^*(1-\alpha)^{\frac{1}{\alpha}}}{(1+\delta)w})^{\frac{1}{\alpha}})$$

2) **w = $w_a$** when the wage matches that offered by domestic firms in autarky, domestic production is viable in both industries. Domestic employment available to foreign firms varies between 0 and the level of employment, h(wa), consistent with specialization in the capital-intensive good.

the following figure illustrates h(w). The amount of labor available to foreign producers, regardless of the level of w, increases with L and decreases with the relative abundance of capital k. In both cases, the intuition is the same: the larger the country or the more abundant the labor force is, the higher the residual level of employment consistent with the capital market equilibrium.

**Graph n°9: Residual Domestic Labor Supply for Foreign Firms Consistent with Domestic Capital Market Equilibrium**



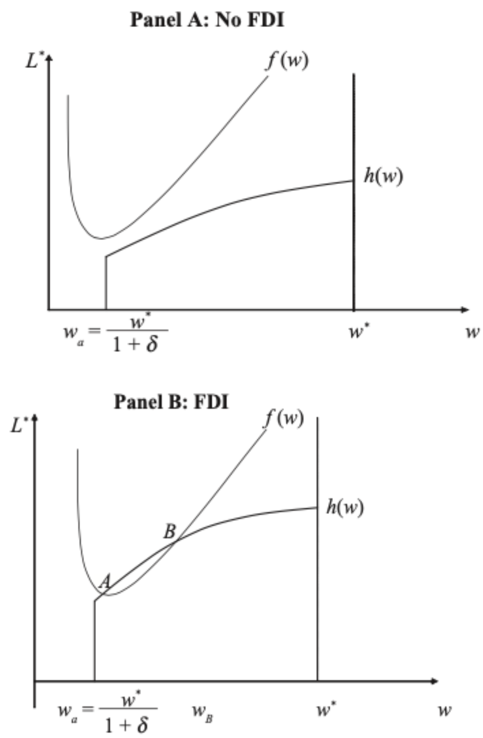
- *the general equilibrium:*

There is a balance with the combinations of foreign employment in the country of residence and salary in which FDI takes place. When the residues of labor supply are equal to the minimum labor requirement of foreign producers.

In Chart A, there is no FDI integration and the domestic wage rate is $w_a$. The foreigner cannot reach the scale to compensate for the fixes cost. It can be due to :

- The fixed cost of foreign investment is too high
- The national economy is small and/or too rich in capital (low L and high k)
- he technological disadvantage of the national country is low (δ low), the local economy is too small or too intensive in domestic capital

**<u>Graph n°10 : Domestic Labor Market Equilibrium after FDI Liberalization</u>**




This situation may explain why FDI never flowed abundantly into China before the 90s. As noted earlier, uncertainty about China's legal and regulatory regime, as well as its relatively backward infrastructure and economy, limited foreign investment in the first few years after economic opening-up. The fixed costs were too high. As the foreign investment situation has become clearer, incentives have been put in place, new areas have been opened and investment has begun to take off. Indeed, in 1990, FDI was equivalent to USD 487 million.

They climbed to $40,715 million in 2000, $114,734 million in 2010 and $119,562 million in 2014 (Claro,2009). [4]

Chart B describes a situation where there is an FDI integration. There are two possible balances when FDI enters China.

**Point** B corresponds to a sustainable equilibrium. The salaries offered by foreign firms are high and there is a large amount of FDI. Thus, domestic firms specialize in the production of capital-intensive goods. All domestic capital is used in the production of x in response to the increase in w/r.

Point A is an unstable equilibrium. Wages offered by foreign firms and FDI are low. this situation is unstable since the slightest increase in wages tilts towards equilibrium B. Foreign firms are ready to expand to infinity, which leads domestic wages to $w_B$.

*Source: Claro, 2009*

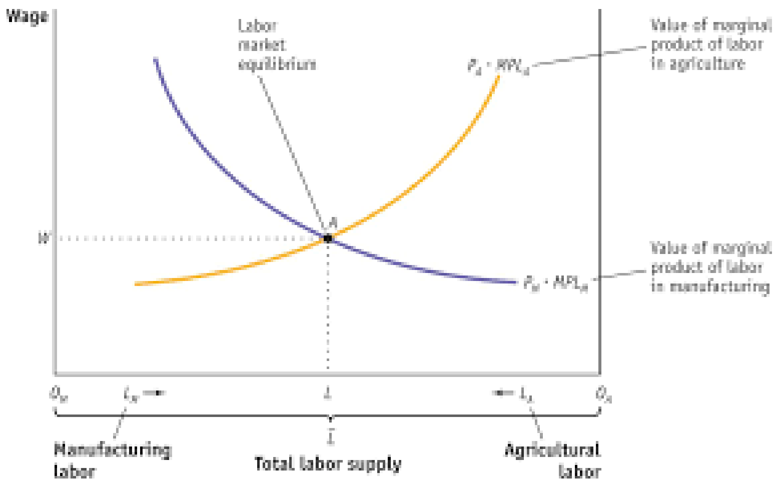
[4] Statistical Yearbook of China

# Appendix M

The factor-specific model assumes an economy with 3 factors of production: capital (K), labor power (L) and land (T). There are two industrial sectors: the manufacturing sector that uses workers and capital in its production process. The second industrial sector is agriculture, which requires the use of workers and land. Workers can move freely between the two sectors in the long run but not in the short run. As in the previous model, the wage is characterized by this same equation once we assume that perfect equilibria exist, there is no reason for it to change between the sectors and thus, the wage between the 2 sectors equalizes. Farmers are willing to pay the same wage as firms.

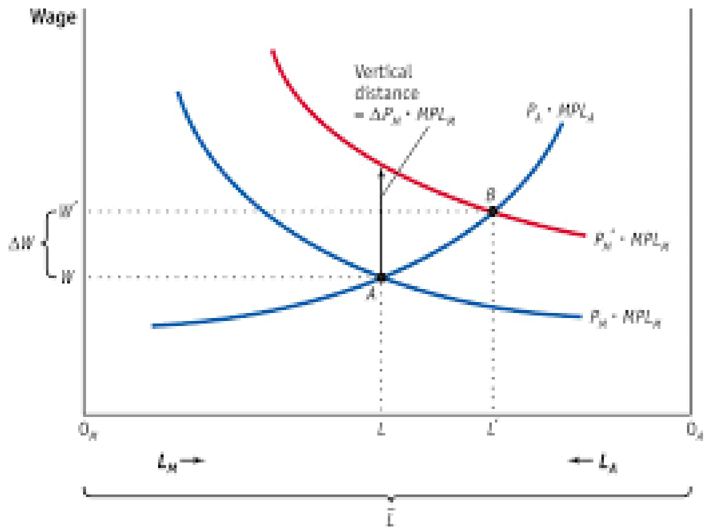
W = Pi*MPLi, (1)

The wage is the worker's compensation and is equal to the product of his marginal productivity in the manufacturing sector and the price in the manufacturing sector if i corresponds to the manufacturing sector and it is equal to the product of his marginal productivity in the agricultural sector and the price in the agricultural sector if i corresponds to the agricultural sector.




**<u>Short-run FDI (specific factors model):</u>**

An increase in FDI is characterized by an increase in capital in the model. This leads to an increase in the marginal productivity of workers in the manufacturing sector because they have more machines to produce. The wage therefore also increases because it is the product of marginal productivity and price. (1) The number of available workers is fixed. More workers are attracted to manufacturing. Labor used in agriculture is withdrawn. The output of agriculture declines while the output of manufacturing increases.




With respect to changes in the rental of capital and land, if workers are withdrawn from agriculture and the price of agriculture does not change, the rental of agriculture declines. The study of the rental of capital is more complex. Marginal productivity of capital in manufacturing may decline due to diminishing returns but increase due to labor drawn into manufacturing, the marginal product of capital tends to increase.

If the change in wages is zero, MPLl is the same at points A and C. Therefore, the ratio Lm/Km is also the same between the 2 points. If the ratio is the same, then the marginal productivity of capital, MPKm, is also the same at points A and C and the rent of capital, Rk = Pk*MPKm is also the same.

However, if we assume an increase in wages, less labor is used in manufacturing, MPKm decreases and Rk also decreases because less labor is used with each machine. In the latter case, the labor-capital ratio increases. Therefore, the rent for capital decreases when the capital stock increases due to FDI. So in the short run, according to the specific factor model, the rents of capital and land holders fall while the wages of workers rise when foreign direct investment takes place.

*Source: Feenstra and Taylor, 2012*