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Brain Drain from Europe to China in a Digital Economy Era?

Over the past several decades, China has significantly affected the European labor market through trade in commodities, via channels discussed in Autor et al. (2013). The same authors (2021) found that these effects can be persistent. For example, Dauth et al. (2021) found that trade exposure benefits highly skilled workers but hurts low-skilled workers in the German manufacturing sector. Kiyota et al. (2021) show that the import penetration of final goods from China has negative effects, but that the import penetration of intermediate inputs could have positive effects on manufacturing employment in six advanced countries and that such positive effects could more than offset the negative effects in some of them.

China is the biggest emerging economy and is quickly evolving from a developing into a developed economy. Several key features will weigh in China's future development: labor costs in China are rising, and the manufacturing sector is moving from labor-intensive to capital- and technology-intensive. China is not only a manufacturing powerhouse, but it is also becoming a leading service provider: the tertiary industry accounted for 54.5 percent of Chinese GDP in 2020.

In the future, the composition of trade will change, and other channels will become more important as emerging technologies and industrial transformation take hold. In this article, we investigate how China's development, such as industrial upgrading, will affect the European labor market, keeping in mind that in the digital economy era the organization of labor is no longer limited by physical space or restricted by borders. Our key contribution is to build a model to allow European high-skilled workers to provide services to Chinese domestic firms remotely, without international migration, and examine how the digital transformation in China might differ in its effect on the European labor market compared with a standard model with international migration. Our results suggest that in a digital economy, the possibility of online international job search, matching, and working remotely will raise the demand and competition for high-skilled workers resulting from China's industrial upgrading and economic development, increasing the tightness of high-skilled but not of low-skilled labor markets in Europe. These results are in sharp contrast with the ones from a traditional model where a European worker can take a job in China through international migration.

KEY MESSAGES

- **In the digital economy era, the organization of labor is no longer restricted by borders**
- **China's development has increased its demand for high-skilled workers**
- **We build a model where European high-skilled workers can provide services to Chinese domestic firms remotely**
- **High-skilled labor demand from China increases the tightness of the high-skilled but not the low-skilled labor markets in Europe**
- **Sharp contrast with traditional model where a European worker migrates to China to take a job there**

BEYOND TRADE EFFECTS

Development of China

China has been undergoing massive macroeconomic transformation, industrial upgrading, and technological progress. For the 2010–2019 period, China's GDP averaged 7.7 percent annual growth, while secondary and tertiary industry growth rates clocked 7.6 percent and 8.4 percent, respectively. In 2019, the tertiary industry accounted for 54.3 percent of Chinese GDP, a significant increase of 10.1 percentage points since 2010. Meanwhile, the secondary industry dropped from 46.5 percent to 38.6 percent over the same period. At the same time, the composition of GDP in European countries remained quite stable.

Technology in China has been advancing rapidly. As reported by the International Federation of Robotics (IFR), China in 2016 was the world's biggest robot market in terms of annual sales and operational stock.



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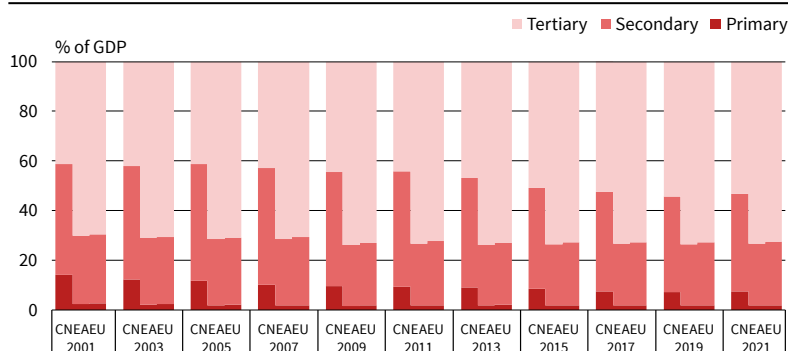


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Figure 1

Share of GDP by Sectors

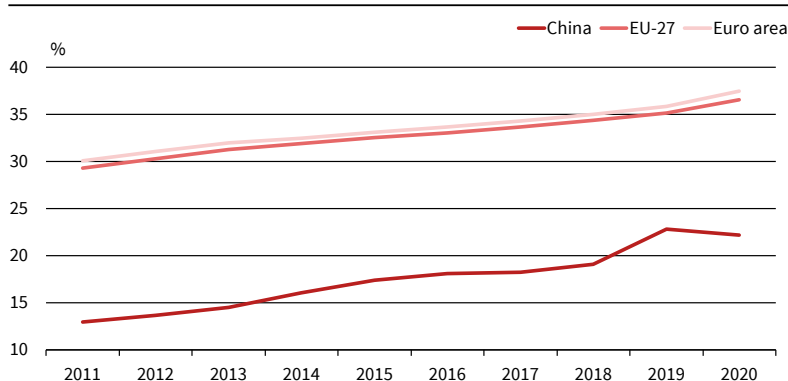


Note: CN - China; EU - European Union, 27 countries; EA - Euro area, 19 countries.
Source: National Bureau of Statistics of China; Eurostat; authors' calculations.

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Figure 2

Share of Employees having Tertiary Education



Source: National Bureau of Statistics of China; Eurostat; authors' calculations.

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By 2017, the robot density in the manufacturing industry (number of multipurpose industrial robots per 10,000 people employed) in China exceeded the world average. At the same time, China is a leading player in the digital and platform economies.

Reverse Brain Drain?

China is one of the EU's most important trading partners. In 2021, it was the third-largest partner for EU exports of goods and the largest partner for EU imports of goods. This has given rise to concerns regarding Chinese import competition and its consequences on employment and wage inequality in local labor markets.

However, on the one hand, new patterns are emerging in the EU-China trade which should be considered. The first is that the manufacturing sector in China is shifting from labor-intensive to capital- and technology-intensive. For example, in 2021, office and telecommunication equipment accounted for 29.3 percent of EU import flows, and transport equipment for 19.8 percent of EU export flows with China. On the other hand, most studies that examine the impact on employment of trade with China only find negative effects on the manufacturing sector. As Coricelli and

Ravasan (2017) point out, the shrinking of employment in manufacturing could be due to competition from international trade or to faster productivity growth in manufacturing relative to services, i.e., the Baumol effect.

Globalization not only affects labor markets indirectly through international trade, but also directly through migration. The flow of high-skilled labor or young talent from emerging to developed economies is commonly known as "brain drain." However, the rapid development of emerging economies has turned them into active competitors for talent, an aspect that had previously been dominated by advanced economies.

Europe and China have both seen an increasing share of employed workers with tertiary education (levels 5–8 in ISCED 2011) during the 2011–2020 period. Data from Eurostat shows that the share of employed workers aged 20 to 64 steadily increased, from about 30 percent in 2011 to around 37 percent in 2020, for the EU (27 countries) and euro area (19 countries). Statistics of China reveals a relatively larger increase, from 12.9 percent in 2011 to 22.2 percent in 2020 (Figure 2). Even though the gap was moderately reduced, by 2.3 percent for the last decades, persistent difference still exists in the skill composition of labor markets between Europe and China. In an era when China is experiencing dramatic demographic and economic transitions, the skills shortage will be a prevalent phenomenon in the country's labor market and could have potential consequences for European labor markets if China's high-skilled labor migration policies are designed to attract more foreign talents.

Several factors are driving the booming demand for high-skilled labor in China. First, China is experiencing a profound demographic change, whereby the working population is shrinking. According to census data, the share of working population (aged 15 to 64) in China decreased from 74.5 percent in 2010 to 68.6 percent in 2020. Working population shrinkage directly reduces the supply of both high- and low-skilled workers. Additionally, population aging will negatively impact individuals' skill acquisition decisions through lower public and private educational investment, which ultimately will affect the skill composition of the general population. Second, the increased robot density led by automation-based technology progress in China is leading to the destruction of traditional routine jobs and creation of skill-intensive routine jobs and non-routine jobs. Third, the growth of modern service industries and manufacturing with higher value added results in greater demand for professionals with specific talents. China is in the process of transitioning from "world factory" for low-end products to an exporter of high-end technology and services. All of the factors mentioned above are contributing to the skills shortage in China.

BRAIN DRAIN FROM EUROPE TO CHINA: THEORETICAL FRAMEWORK AND NUMERICAL ILLUSTRATION

As discussed above, the Chinese economy's transition to high-value-added manufacturing and modern service industries results in a widening supply-demand gap for high-skilled labor. In this section, we present two benchmark models which incorporate labor market search frictions.

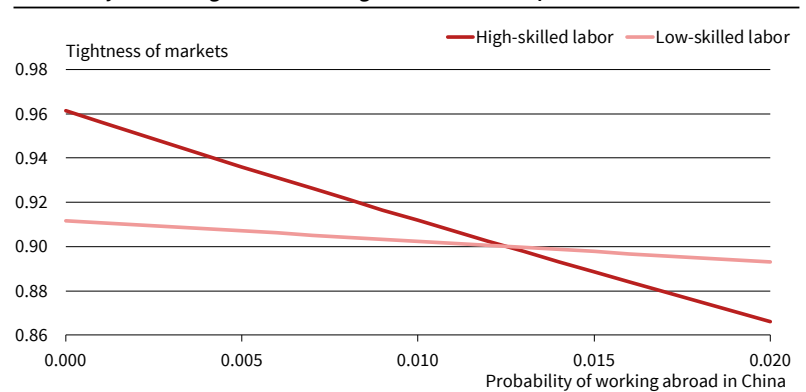
The first one is a standard migration model: high-skilled workers in Europe consider working abroad in China through international migration. The increased probability of working abroad for high-skilled workers will affect the willingness of local firms to create high-skilled positions and will probably also affect other labor market conditions.

In the digital economy era, online labor markets facilitate international search and matching between high-skilled labor in Europe and high-skilled jobs in China, making it possible for high-skilled workers in Europe to provide services to Chinese firms without physically migrating to China. Thus, in the second model, we assume that high-skilled workers are potentially matched with two sources of high-skilled jobs offered by European and Chinese firms with equal probability. The booming demand for high-end talents by Chinese firms results in an exogenous shift of the demand curve of high-skilled workers in the European labor market, which directly increases the tightness of the high-skilled market.

Standard Model

We develop a simple migration model based on Mortensen's and Pissarides's labor search-matching framework (Mortensen 1982; Pissarides 1984). Our model emphasizes two features: first, that the transformation of China from a low-skilled, labor-intensive economy to a capital-intensive, innovation-based economy spurs rapid growth in the demand for high-end talents. We capture this feature by assuming that high-skilled jobseekers (both employed and unemployed) in Europe have an increased probability of migrating abroad to work for a Chinese firm. Second, the stronger demand for high-skilled labor led by skilled-based technology change in China exerts a heterogeneous influence on European labor markets. Accordingly, we consider two types of workers in the European labor market: high- and low-skilled workers. High-skilled workers, defined as workers with tertiary education, can look for jobs in both the European and the Chinese labor markets, performing such jobs through international migration, while low-skilled workers could only be employed by European firms. We further assume that each migrating high-skilled worker is replaced by an identical unemployed one such that the skill pool of European labor market is unchanged by international migration.

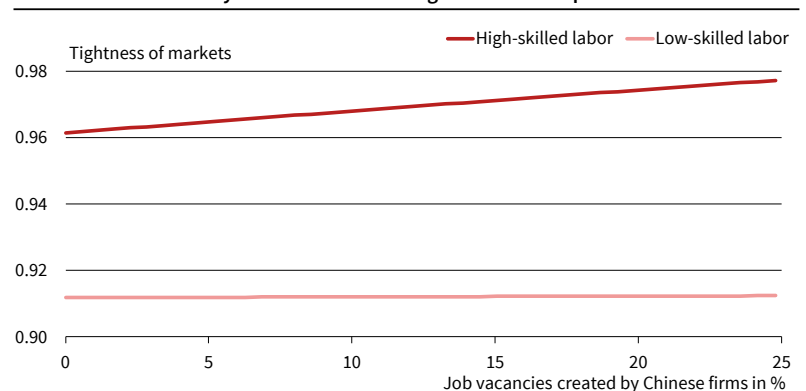
Figure 3
Probability of Working in China and Tightness of the European Labor Market



Source: National Bureau of Statistics of China; Eurostat; authors' calculations.

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Figure 4
Online Job Vacancies by Chinese Firms and Tightness of European Labor Market



Source: National Bureau of Statistics of China; Eurostat; authors' calculations.

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On the production side, a homogeneous final good is sold in a competitive market by a representative firm exhibiting constant returns-to-scale with high- and low-skilled labor being intermediate inputs. The complementarity between high- and low-skilled workers is governed by the elasticity of substitution in the production function. We assume that high- and low-skilled workers are imperfect substitutes in the production of a final good, which implies that the marginal product of high-skilled input depends positively on the amount of low-skilled labor employed but negatively on the amount of high-skilled labor employed.

The search-and-matching and wage determination processes follow the standard search-and-matching model. We do not allow cross-skill matching and on-the-job search, which means that our model does not allow high-skilled workers who are initially mismatched with low-skilled jobs to conduct an on-the-job search for high-skilled jobs. Additionally, the labor market's skill structure in our model is exogenously given.

There are two channels through which an increase in the probability of a successful match between European high-skilled workers and Chinese firms affects wages and unemployment rates. The interaction of these two channels determines the end results. First, an increase in the probability of working abroad in China results in a greater gap between

high-skilled workers and high-skilled jobs in Europe, putting a downward pressure on firms' expected profits from creating a high-skilled position. The prospect of working abroad in China also discourages entry of high-skilled jobs and decreases the tightness of the high-skilled labor market in Europe. Consequently, the outside option of finding a high-skilled job for high-skilled workers goes down, which reduces their wages and raises the unemployment rate.

Second, a reduction in the tightness of the high-skilled labor market due to an increase in the probability of international migration decreases the amount of high-skilled inputs in the production of final goods, which raises the marginal product of high-skilled labor and lowers that of low-skilled labor. This complementarity-substitutability channel raises the potential profits of opening high-skilled job positions, which induces entry of high-skilled jobs and brings up labor market tightness. For the low-skilled workers, the opposite is true. Wages and unemployment rates, as a result, adjust in accordance with changes in market tightness.

Modified Model

In the modified model, we highlight the interaction between the digital economy and international migration. The rise of the digital economy partially removes the physical boundaries of nations and provides an online international labor market platform, which facilitates international hiring and outsourcing (Goldfarb and Tucker 2019). It is also possible for workers to provide services remotely. Consequently, in the modified model two kinds of jobs are created in the high-skilled labor market: one by European firms in the traditional offline labor market, which is endogenously determined, and one by Chinese firms through an online labor market that is exogenously given. High-skilled workers conduct their search in both the offline and online high-skilled labor markets and seek potential matches with both sources of jobs. If the European high-skilled workers find matches with a Chinese firm, they can supply their labor to the Chinese firm without migrating to China. China's digital transformation and industrial upgrading increase the demand for high-skilled labor, create more job vacancies in the online labor market, and offer the possibility of providing services to Chinese firms without migration. As a result, the tightness of both the high- and low-skilled labor market benefits from the exogenous rise of the digital international labor market induced by China's development.

Numerical Illustration

To quantitatively gauge the effects of China's digital transformation on the European labor market, we calibrate our model to match European data for the period 2012–2021 and simulate the effects of the in-

crease in the probability of working abroad in China in the traditional model, and the increase in the job vacancies of online high-skilled labor market in the modified digital economy model.

As shown in Figure 3, in the traditional migration model an increase of migration probability from 0 to 0.02 significantly reduces the tightness of the high-skilled labor market by around 0.1 and moderately decreases that of low-skilled labor market by about 0.02. This indicates that for a high-skilled labor market the negative job-separation effects more than offset the positive diminishing-marginal-productivity effects of the option of working abroad. As a result, the wage rate and employment rate of the high- and low-skilled labor market decrease as the probability of working abroad in China rises.

In Figure 4, we present the simulation exercises for the effects of an exogenous increase in job vacancies created by Chinese firms through an online labor market and the possibility for high-skilled worker to work remotely. We show that high-skilled vacancies posted by Chinese firms is positively correlated with tightness and wage rate, while negatively correlated with the unemployment rate of the high-skilled in Europe. An increase of vacancy-unemployment ratio from 0 to 25 percent results in a rise of tightness in the high-skilled market about 0.015. The low-skilled labor market, on the other hand, responds moderately to the exogenous expansion of unfilled high-skilled vacancies through a complementarity-substitutability channel. Thus, the entry of Chinese firms into the high-skilled labor market directly raises market tightness even though a higher outside option for high-skilled workers discourages the creation of high-skilled positions by European firms, which indirectly reduces market tightness.

The numerical exercises quantitatively demonstrate that the labor market consequences of a rise in China's demand for high-skilled labor could be quite different under different scenarios. In a traditional economy, a high-skilled worker can only take a position in China through international migration, and our results suggest that with the development of the Chinese economy and the associated increase in the demand for high-skilled work, the tightness of high- and low-skilled labor markets both decrease, but the decrease in the high-skilled labor market is more significant. A digital economy, in contrast, offers the possibility of an online international job search and matching as well as working without having to migrate. In this case, the demand and competition for high-skilled workers from China increases the tightness of the high-skilled but not the low-skilled labor markets.

DISCUSSION AND POLICY CONCLUSION

Ever since the paper by Autor et al. (2013) on how international trade affects local labor markets, the

topic has become an important one in both academic and policy circles. Though a large number of studies find that the exposure to international trade has negative effects on employment opportunities for the low-skilled workers in the manufacturing sector of advanced economies, the effects could be quite heterogeneous depending on whether the interest group is low-skilled or high-skilled workers, and whether the trade commodity is final goods or intermediate inputs. Few studies distinguish trade effects from the Baumol effect.

Besides international trade, globalization also directly affects local labor markets through international migration. Along with the development of China, the demand and competition for high-skilled workers will inevitably affect the European labor market, especially for the high-skilled segment. With technological progress and the digital transformation, the labor market itself is changing. Online job search and matching is becoming more and more important: the organization of labor into production processes is no longer limited by physical space or restricted by borders.

Our model, which allows workers to supply their labor remotely, suggests that the demand and competition for high-skilled workers from China resulting from its industrial upgrading and economic development increases the tightness of the high-skilled but not the low-skilled labor markets in Europe.

The implication of our finding is that in the digital economy era, international mobility of labor is becoming less necessary since workers can provide their services remotely. This change can create win-win situations for both the EU and China. On the one hand, China is able to benefit from EU high-skilled workers; on the other, the European labor market is not negatively affected by the shock on the demand curve of its high-skilled workers. These results are in sharp contrast with the ones from a traditional model where a European worker can take a job in China through international migration.

REFERENCES

- Autor, D. H., D. Dorn and G. H. Hanson (2013), "The China Syndrome: Local Labor Market Effects of Import Competition in the United States", *American Economic Review* 103, 2121-2168.
- Autor, D. H., D. Dorn and G. H. Hanson (2021), "On the Persistence of the China Shock", *Brookings Papers on Economic Activity*, 381-447.
- Coricelli, F. and F. R. Ravasan (2017), "Structural Change and the China Syndrome: Baumol vs Trade Effects", *CEPR Discussion Papers* 12069.
- Dauth, W., S. Findeisen and J. Suedekum (2021), "Adjusting to Globalization in Germany", *Journal of Labor Economics* 39, 263-302.
- Goldfarb, A. and C. Tucker (2019), "Digital Economics", *Journal of Economic Literature* 57, 3-43.
- Kiyota, K., S. Maruyama and M. Taniguchi (2021), "The China Syndrome: A Cross-Country Evidence", *World Economy* 44, 2758-2792.
- Mortensen, D. T. (1982), "Property Rights and Efficiency in Mating, Racing and Related Games", *American Economic Review* 72, 968-979.
- Pissarides, C. A. (1984), "Efficient Job Rejection", *Economic Journal* 94, 97-108.