The impact of Foreign Direct Investment on wage inequality in Egypt's industry sector

Prepared

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Journal of Business Research

Faculty of Commerce -Zagazig University

Volume 44 - Issue 4 October 2022

link: https://zcom.journals.ekb.eg/

Abstract

In this paper, we try to evaluate the impact of FDI inflows, on domestic wage inequality within industry sector in the Egyptian economy through learning process as technology transfer from foreign firms to domestic firms. Based on a model of the impact of new technologies on wage inequality developed by Aghion and Howitt (1998). Following Figini and Görg (1999); and Figini and Go¨ rg (2011) models for Ireland, and some selected developing and developed countries respectively.

In the econometric analysis we use Theil index as a proxy for wage inequality in industry sector in our VAR model for time series data over the period 1975-2014. According to the VIF test and the existence of the multicollinearity, we can not check from non-linear relationship between Theil index (wage inequality) and FDI inflows within the industry sector, However, we check from linear relationship between Theil index and FDI using VAR in difference model, which is suitable and useful model, when the variables included in the model are not exogenous. Our results indicate that, a one per cent increase of FDI results in a decrease of income inequality (Theil index) by 0.000113. which indicate that domestic firms may learning from foreign firms.

Key Words

FDI; Wage Inequality; industry sector; Egypt.

JEL Classification

F21;J31;L16

1- Introduction

Foreign direct investment (FDI) is one of a key component of economic globalization. Developing countries consider FDI inflows as a crucial factor that supports economic growth, development, modernization, and employment. Therefore, many of developing countries adopt capital liberalization and aggressive FDI promotion policies. However, one of the biggest concerns of globalization's critics is its impact on inequality and poverty. This paper is concern with the wage inequality as the wage is the main source of personal income for majority of people, the wage inequality plays an important component in the income inequality.

According to the literature, FDI can affect wage inequality directly (foreign wage differentials) and indirectly through FDI spill overs on domestic firms(spill over effect).Foreign enterprises may offer higher wages than domestic firms because, they are larger, and more capital intensive required more skill intensive than domestic firms (Chen et al., 2011). Therefore, higher wage inequality, mostly due to an increase in skill premium. This effect is larger in developing countries where skilled labor is scarce. In addition, foreign firms can pay higher wage for their labor in developing countries for reasons unrelated to the productivity of labor, according to heterogeneous firms model, wage variations would be appeared among workers with similar observed characteristics, because of; (1)differences in workforce composition (competitive labor market) (Helpman et al., 2012); (2) efficiency wages (labor market frictions), foreign firms have its own specific advantages over the domestic firms (e.g. Technology, Know how), in order to, maintain these advantages, foreign firms pay efficiency wage to reduce worker turn over to minimize the leakage of foreign specific assets(Arnal & Hijzen, 2008) ; (3) a qualitative change in the composition of jobs (labor market with search and matching

friction)(Acemoglu, 1999). Furthermore, there are other factors for why foreign firms pay different wages from wages paid in domestic firms such a; internal fairness policies within multinational enterprises (MNEs)may prevent a large wage variances from appearing among employees of similar quality in different countries, there by increasing wages in low-wage regions firms (Chen et al., 2011); and workers may prefer local firms, therefore , foreign firms pay wages higher than domestic to compensate local workers from working at disfavours enterprise (Peluffo, 2015).

FDI can affect on the wage growth and level in domestic firms indirectly, through its technology and competition, spill overs. Positive wage spill overs help domestic firms to catch up with their foreign competitors, whereas negative wage spill overs widen the wage gap between foreign and domestic firms. For technology spill overs, domestic firms may imitate new technology introduced by foreign firms (demonstration effect) orgain more access to the knowledge of foreign firms through labour turnover, where workers who were trained or previously worked at the foreign subsidiary may transfer information, knowledge, and skills to local competitors by moving to work in the domestic firms. Foreign firms can transfer technology through forwards and backwards linkages, multinationals may transfer technology to firms that are potential suppliers of intermediate goods or are potential buyers of their own products, therefore, FDI constitutes a direct channel for knowledge diffusion that can assist in upgrading domestic firms, technological and other capabilities and may reduce wage inequality (Gorodnichenko et al., 2014).

Regarding the competition spill overs, when FDI entry to the host country, foreign firms compete with the domestic firms in the factor as well as the good market. Foreign firms create additional labor demand by hiring

local labor. Since foreign invested firms often pay higher wages, they may raise wages for all firms in competitive labor market, consequently, domestic firms also have a tendency to raise the wage (Lin et al., 2009). However, in the case that foreign firms poach the best workers away from the local competitors and thus lower both the quality of labor and the wage level in domestic firms(Nguyen et al., 2019).In addition, the entry of foreign firms into the domestic market can reduce the market share of domestic firms or even replace the domestic firms (crowd out effect) or /and FDI can create positive spill overs (crowd in effect) complement the domestic firms, depending on the ability of competitiors to compete, survive in the market and the ability to learn or/ imitiate foreign firms(Chen et al. (2017); Apergis et al. (2006), Oualy (2019)).

This paper focuses on wage inequality within industry sector in Egypt during the period 1975 – 2014.Egypt represents a most interesting case to assess the distributional effects of FDI inflows for some reasons. First, the structure of the Egyptian economy has significantly changed since the mid-1970s,Egyptadopted an open-door economic policy “Infitah", shifted to a private sector-led growth and market-based economy, issued several investment laws aimed to improve the investment climate, especially for foreign direct investment, resulted in steeply increasing FDI in Egypt to be the largest recipient of FDI in Africa. Despite the decline of FDI inflows to Africa in 2019, by 10 % to $ 45 billion compared to year 2018, flows to Egypt increased by 11% to $ 9 billion (Giroud & Ivarsson, 2020).At the same time, inequality in Egypt has increased. The parallel increasing of FDI and inequality call for investigate the role of FDI in increasing income inequality. Second, Egypt is a developing country with the population exceed 100 million people, witnessed Arab spring revolution in the year 2011, with one main request for social equality. The purpose of this study

to test the impact of FDI inflows through learning process as technology transfer from foreign firms to domestic firms, specifically, this paper focusing on domestic wage inequality within industry sector in the Egyptian economy following (Aghion and Howitt (1998); Figini and Görg (1999); and Figini and Go¨ rg (2011)) models.

Aghion and Howitt (1998)developed endogenous economic growth theory depend on the notion of general- purpose technologies (GPTs). according to Bresnahan and Trajtenberg (1995)as cited in Aghion and Durlauf (2014), GPTs is defined asa technological innovations that affects production and / or innovation in many sectors of an economy and the well- known examples in economic history include the steam engine, electricity, the laser, turbo reactors, and more recently the information technology (IT) revolution. Most GPTs are characterized by three essentials features. (1) Pervasiveness: GPTs are used in most sectors of an economy, therefore, generate noticeable macroeconomic effects. (2) Scope of improvement: GPTs tend to underperform upon being introduced; only later dothey fully deliver their potential productivity growth. (3) Innovationspanning: GPTs make to invent new intermediate products and to generate new secondary innovations of higher quality. Even though each GPTs raises output and productivity in long run, it can also cause cyclical fluctuations while the economy adjusts to new GPTs. The process of the economic adjustment to new GPTs is not easy and require costly restructuring and adjustment to take place. Therefore, opposite to the predictions of real-business-cycle theory, the initial effect of a positive technology shock may be to reduce output, productivity, and employment, not to raise them (Aghion & Durlauf, 2014).

Figini and Görg (1999);and Figini and Go¨ rg (2011) models empirically investigated the Aghion and Howitt (1998)endogenous economic growth through the spread of technology change in Ireland, and in some selected

developing and developed countries respectively, more details will be given in theoretical framework section 4.

The remaining paper is organized as follows. Section 2 reviews the literature. Section 3 presents stylized facts for FDI inflows & wage inequality. Section 4presents a theoretical framework used to examine the impact of FDI on domestic firms' wages. Section5presents the econometric specification and data. Section 6provides empirical results and discussions. Section 7 concludes the paper.

-Literature Review

The pioneering work that introduce the evidence to support that the foreign firms pay higher wages than domestic firm was conducted in North-south model by(Feenstra & Hanson, 1995), FDI found to be positively correlated with the relative demand for skilled labor in Mexico over the period 1975-1988, and could explain a large proportion of the increase in the skilled labor share of total wage, responsible for increase the wage inequality. followed by several studies reached to the same conclusion even once other firm and worker characteristics are taken into account., For example, (Aitken et al. (1996) ; Villarreal and Sakamoto (2011))for Mexico and Venezuela, (Girma et al. (2001) ; Conyon et al. (2002) ; Taylor and Driffield (2005)) for united kingdom, (Lipsey & Sjöholm, 2004) for Indonesian manufacturing sector, (Chen et al. (2005) ; Chen et al. (2011)) for China, (Feliciano & Lipsey, 2006) For U.S. Industries.

Empirical studies investigating the relationship between FDI and income wage through spill over effect have had mixed results. For example, (Aitken et al. (1996) ;Villarreal and Sakamoto (2011)), (Girma et al., 2001) and (Feliciano & Lipsey, 2006) found no overall spill over effect on the wage level in Mexico, United Kingdom and US respectively.

Other studies revealed positive spill over effect on the wage level which mean that FDI contribute to decrease the wage inequality in United Kingdom (Driffield & Girma, 2003),China (Wei and Liu (2006) ; Indonesia (Tomohara & Takii, 2011), Mexico (Sharma & Cardenas, 2018).Whereas other studies revealed negative spill over effect on the wage level where FDI increase the wage inequality in Ireland (Barry et al., 2005), China (Hu and Jefferson (2002) ; Chen et al. (2011)), and Vietnam (Nguyen et al., 2019).

According to (Figini & Go¨ rg, 2011)the relationship between FDI and wage inequality in developing countries is non- linear relationship(an inverted-Ushape) depend on the economic development. His result suggested that wage inequality increases with FDI inward, but this effect diminishes with further increases in FDI. To the best of our knowledge,(Abouelfarag & Abed, 2018) is the only study examining the impact of FDI though the productivity spill overs on the overall average wages in Egypt and in some economic sectors during the period from 1985 to 2015by using ARDL model. The findings indicate that FDI has positive spill over effect on the wage level.

2- Stylized Facts of FDI and wage Inequality in Egypt

Since the mid-1970s, Egypt has adopted an open-door economic policy, "*Infitah*", which featured the Egyptian legislator issuing several investment laws. The first and mt prominent law, *Law No. 43*(1974), aimsat building an investment climate in which Arab and foreign investments play an important role in creating new production capacities and expanding existing production capacities, promoting the role of the private sector in the economy, as well as diversifying and aligning Egypt's economic structure with the requirements of global economic and social development.

2.1Trend of FDI inflows

Figure 1exhibits the trends of Egypt's FDI inflows in current price over the period from 1975 to 2014. Before 2003, the FDI inflows in current prices are at a low and relatively stable level. In contrast, after 2003, the FDI inflows increase, but become more volatile. The low level of FDI inflows before 2003 suggests that despite the issuance of several investment laws that intend to attract FDI, the macroeconomic and political instability appears to prevent them from doing so. Such instability includes the high inflation (> 20%) and high unemployment (> 10%) in the late 1980s, assassination of President Anwar Sadat in 1981, decreasing share of Arab countries in attracting FDI as a result of disrupted political relations following the Camp David in 1979, and recession in the beginning of implementing economic reform in Egypt. In addition, the low level of FDI inflows is also due to the events that Middle East witnessed in the beginning of 1990s (Iraq's invasion of Kuwait) and decreasing world FDI inflows from the slowdown in the world economy and the event of September 11, 2001.

The FDI inflows grew approximately by 48 times from 2003 to 2007, reaching USD 11578 million in 2007, owing primarily to improvement in the investment climate with the issuance of several investment laws, for, *Law No. 88* (2003) guarantees the right to repatriate income earned in Egypt. *Law No. 13* (2004) allows investors to start activities with temporary licenses, before obtaining the required licenses. *Law No. 91* (2005) provides an investment incentive in the form of a discounted taxable net profits. *Decree No. 548* (2005) grants foreigners the same legal rights as Egyptian nationals with regard to ownership of residential units in the tourist areas of Sidi Abdel-Raman, Hurghada, the Red Sea coast, including

the beach resort of Hurghada, Ras Al-Hekma, and the Mediterranean coast in Matrouh Governorate.

the increasing trend did not sustain, with the net FDI inflows dropping to the bottom of US$ -483 million in 2011 as many foreign investors halted the on-going investment and some left the country due to political instability in the early 2011 (the revolution of 25 January). However, The FDI inflows recovered after 2011, possibly due to the presidential elections, the new constitution in 2014, and further steps that has been taken by Egyptian government to improve the business climate for foreign investors. For example, *Law No. 12* (2012) allows foreign investors to invest in Sinai Peninsula under certain conditions. Decree No. 1115 (2012) established a Governmental Group for Settlement of Investment Disputes. Chaired by the Minister of Justice, the Group is authorized to investigate investors' complaints of public entities. In 2014, the Egyptian government invited foreign investors to participate in projects that took place in the Suez Canal Economic Zone, a major industrial and logistic services hub.

<insert Figure1 here>

2.2 Wage inequality

Figure (2) demonstrates the wage inequality within the industry sector, measured by Theil index sourced from the university of Texas inequality project. the wage inequality has been non-linear upward trending from 1975 to 2014, the Theil index peaks at 0.1595 in 2003, with some periods of decreasing Theil index (improving wage inequality).

<insert Figure2 here>

3 Theoretical frameworks

The theoretical framework used in empirical methodology is depended on Aghion and Howitt (1998), Figini and Görg (1999); and Figini and Go¨

rg (2011) models. Aghion and Howitt (1998)developed an endogenous economic growth of the spread of technology through the phenomenon of social learning. That is, the way afirm or typically learns through labor to use a new technology is not to discover everything on its own but to learn from the experience of other firms in similar situation. It is worthwhile for a firm to try to use the procedures of these successful firms as "template", it must be able to learn from other firms.

The model Study the effect of the arrival of single GPT on economic growth and the wage inequality in the economy, under the assumption that the arrival rate μ is so small that there is insignificant probability that the next GPT will arrive before almost all sectors have adopted the new technology and that the amount of the research of each sector is given by a fixed endowment of specialized research labor. Therefore, all the dynamics will result from the effects of social learning on the payoff rate to experimentation.

Aggregate output at any point in time is produced by labor according to the constant –returns technology as in Aghion and Howitt (1998)model is:

$$\boldsymbol{Y = \left\{\int_0^1 A(i)^{\propto} x(i)^{\propto} di\right\}^{1/\alpha}} \qquad \textbf{(1)}$$

Where y is the total output produced in each sector i. A is equal to the technology parameter; A (i) = 1 in sectors where the old GPT is still used, and A (i) > 1 in sectors that have successfully innovated (sectors used new technology), whereas x(i) is manufacturing labor used to produce the intermediate good in sector i, where society's fixed stock of labor has two competing uses, it can produce more of existing intermediate good (manufacturing labor) , or the labor can be used in research to discover new intermediate good used in raise the technology parameter (A) by a constant factor, ɣ >1 (research labor) .,

Under the assumption that a new GPT must come and then the intermediate good must be invented (by research labor) to implement a new GPT. An innovation in each sector i requires three stages. First, the economy wide GPT must be discovered. Second, a firm in that sector must acquire ‘a template’’ on which to base experimentation. Third, the firm must use this template to discover how to implement the GPT in its particular sector. In other words, all sectors are in one of three states; State (0) sectors have not acquired a template. State (1) sectors have a template but have not yet discovered how to use it. State (2) sectors have succeeded in making the transition to the new GPT.

A sector to move from state (0) to state (1) if a firm in that sectors discovers a template by “imitation’’ that by observing a number of firms (k) similarly located firms that have made a successful transition to the new GPT. For sector move from state (1) to state (2), the firm with template must employ at least N units of labor per unit (research labor). And under the assumption that the labor force is divided into skilled (educated labor) and unskilled labor (uneducated labor) ((skill differentials of labor) and Educated labor can work in both research and manufacturing, whereas uneducated labor can only work in manufacturing good. Beside assuming that, the supply of skilled labor is increased over the time due to increasing in the school enrolment or educated labor Therefore, The transitions from old to new GPT have taken into two stages; stage one (in the early stage of transition), the numbers of firms using the new GPT is too small to observe the whole supply of skilled labor force, which is mainly used in the old or manufactured sectors at the same wage as their unskilled labor. Therefore, the labor market in the early stage will be unsegmented with the real wage and aggregate output determined previously as before.

At the second stage, labor market will be segmented, with skilled workers begin exclusively employed at higher wages by new sectors while the unskilled labor remains in the old sectors, leading to higher wage inequality (a function of the ratio between skilled and unskilled wages) increases and in the later of the second stage by the end of the adjustment process, all firms have made the jump into Stage 2, and they use the new technology for production purposes. In another words, in the second stage, wage inequality first increases and then drops. The speed of adjustment depends mainly- among other factors- on the probability that a firm learns through imitation, the probability that a firm makes a discovery of a template on its own and the share of R&D in the economy, (Figini & Go¨ rg, 2011). Therefore, Aghion and Howitt (1998) model introduced an alternative explanation of Kuzents curve in terms of transition to a new technology paradigm instead of Kuzents's transition to an urban economy.

Figini and Görg (1999) and Figini and Go¨ rg (2011) models investigated empirically Aghion and Howitt (1998)Endogenous Economic growth theory by examining the role of FDIin wage inequality- as they considered FDI as a main source of introducing new technology- in the manufacturing sector in the Ireland economy for the period from 1979 to 1995 and in some selected developed and developing countries for a period from 1980 to 2002 , respectively. The two support the expected relationship between the introduction of new Technology and wage inequality according to Aghion and Howitt (1998) Endogenous Economic growth theory. Both studies found nonlinear relationship between FDI and wage inequality in Ireland economy and in developing host countries.

Following Figini and Görg (1999); and Figini and Go¨ rg (2011) models, our model consider FDI as the main and the only source of introducing new advanced foreign technology to the economy of hosting

countries , and as "role models" for domestic firms; domestic firms learn by imitating the more advanced production technologies used in FDI, where FDI considered as a bundle of technological, managerial knowledge, and financial capitalandreinterperting Aghion and Howitt (1998) model in terms of the impact of FDI on introducing new technology in the economy and in turn FDI impact on the overall wage inequality in the Egyptian industry sector over the period 1975-2014.

The introduction of new technology through FDI leads to two stages of development. First, domestic firms need to acquire a template for experimenting with the new technology introducing through FDI as they are unfamiliar with it. In this stage domestic firms still produce output using the old technology, at the same time they invest in R&D to discover how to use such a template, particularly through the imitation offoreign firms that already use the new technology. Initially, the foreign firms played as "role models" as they have higher technology than domestic firms. In stage 2, firms use the newly acquired template to produce the final output through the application of the new technology and, by the end of the adjustment process, all firms have made the jump into stage 2 and are using the new technology in production. Therefore, skill premium (the fraction of the wages of skilled labor to unskilled labor) initially increases when social learning is accelerating by domestic firms through imitating the foreign firms and then, the premium keeps on increasing although more slowly during the remaining part of the transition process, lead to increasing the wage inequality due to raise the demand of skilled labor and eventually at the end of the adjustment process wage inequality decreases as everyone earing the same skilled labor wage due to fall the demand of unskilled labor to zero as all firms transfer from stage (1) to stag (2). Thus, the relationship between FDI and wage inequality take an inverted U shape due to the transition process to new technology in the whole economy.

4Methodology and data

To examine the interrelationship between FDI and wage inequality in industry sector this paper makes use of a Vector Autoregressive (VAR) model. VAR type models are particularly useful; when the variables included in the model are not exogenous. In light of the above theoretical discussions and the availability of data, the model used inthispaperis presentedinEq. (2) as follows:

$$y_t = c + \pi_{11} y_{t-1} + \pi_{12} y_{t-2} + \cdots \ldots + \pi_{1p} y_{t-p} + \sum_i^n Z_{1t-p} + \varepsilon_\tau \quad \textbf{(2)}$$

$$z_{2t} = c_0 + \pi_{21} z_{2t-1} + \pi_{22} z_{2t-2} + \ldots\ldots + \pi_{2p} z_{2t-p} + \sum_i^n y_{t-p} + \varepsilon_\tau$$

$$y_t = Theilindex, z_t = [FDI, FDI^2, SE, TO, GDP]$$

Where Theil represents the Theil index and reflecting the wage inequality in industry sector, FDI stands for the FDI inflows in industry sector*;* The quadratic term for FDI is included in order to allow for the non-linearity suggested by the theoretical framework; SE represents the secondary school enrolment as a percentage of gross enrolment; TO denotes trade openness; *GDP* represents the gross domestic product per capita (constant 2010 US$);$\varepsilon_\tau$is a random variable which captures the effect of all omitted variables; and$\pi_{11}, \pi_{12}, \pi_{1p,} \pi_{21}, \pi_{22}, and\ \pi_{2p}$ are unknown population parameters.

Education (or human capital) is another factor that affects income inequality. Workers with higher education level (more human capital) tend to earn higher wages. In equation (2), we control this factor by the secondary school enrollment as a percentage of gross enrollment (*SE*).However, its time series has missing values in the years 1998,2005,2006,2007, and 2008, which we interpolate for the estimation purpose. According to the Heckscher-Ohlin-Samuelson model (with two types of labour), developing countries tend to specialize in producing and

exporting unskilled-labour-intensive goods because they are relatively well endowed with unskilled labour, which would result in an increase in the wages of unskilled labourrelative to those of skilled labour, leading to a reduction in income inequality. Hence, we expect trade openness (*TO*) to negatively affect income inequality. The variable, GDP per capita (*GDP*), controls for the potential influence of economic development on income inequality. All variables are measured on yearly basis from 1975 to 2014.

The FDI inflows (*FDI*) in industry sector, the data of FDI inflows are sourced from General Authority for Investment and Free Zones (GAFI). The Theil index, measurement of income inequality, is obtained from the university of Texas Inequality Project (UTIP). UTIP provides a measuring of inequality in wages and earning of industry sector, uses Theil's T statistic to compute inequality indexes from industrial, regional, and sectoral data. The other data come from the World Bank Development Indicators. Our sample covers the period from 1975 to 2014, chosen based on data availability.

Table1 shows the definitions and summary statistics of these variables, and Figure 1 presents their time series.

<insert Table 1 here>

<insert Figure 3 here>

5 Estimation Results:

It is possible that, in equation (1) the existence of multicollinearity between the independent variables. Therefore, we conducted the variance inflation factors (VIF) to check whether there iscollinearity among predictor variables within the model. The VIF test is computed by taking the ratio of the variance of all a given model's betas divide by the variance of a single beta if it were fit alone**.** The larger the value of VIF, the more

"troublesome" or collinear of the variable. As a rule of thumb, if the VIF of a variable exceeds 10, variable is said be highly collinear. The VIF obtained in our model for all the variables; Foreign direct investment in industry sector (FDI), quadric Foreign direct investment in industry sector (FDI^2), GDP per capita (GDP), secondary school enrolment (*NSE*), and trade openness (To), are, 10.13, 11.44, 3.64, 3.43 and 1.28 respectively suggesting existence of multicollinearity issue for the variables FDI and (FDI^2).Hence our interpretation will be based on the regression without (FDI^2).The VIF obtained for the all variables without FDI^2 are 1.78 for FDI, 3.61 for GDP, 3.42 for NSE and 1.19 for TO, all are less than 10% which means that the model without FDI^2 does not suffer from the multicollinearity problem.

As it is essential that all variables in the VAR methodology are stationary. To this end, augmented Dickey Fuller (ADF) was carried out on the time series in level and differenced forms. The results suggest that each series is a I (1) variable at the 95% interval confidence Given these results, all variables were entered in difference form into the VAR. Table 2 reports the results of the augmented Dickey Fuller test.

<insert Table 2 here>

Next, to construct the VAR model, we selected the optimal lag the best fit the model. To determine the amount of lag that best fits the model, the criteria used are based on Selection Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hanna Quinn Information Criterion (HQIC), which produces the minimum value. results can be seen in table 3, as shown according to two criterion (AIC) and (HQIC) the optimal lag suggests 4 lags for the VAR model.

<insert Table 3 here>

The VAR model can be specified as follows:

$$\mathrm{d}Theil_t = c_1 + \pi_{11} dTheil_{t-4} + \pi_{12} dFDI_{t-4} + \pi_{13} dSE_{t-4} + \pi_{14} dTO_{t-4} + \pi_{15} dGDP_{t-4} + \varepsilon_t \quad (3)$$

$$\mathrm{d}FDI_t = c_2 + \pi_{21} dFDI_{t-4} + \pi_{22} dTheil_{t-4} + \pi_{23} dSE_{t-4} + \pi_{24} dTO_{t-4} + \pi_{25} dGDP_{t-4} + \varepsilon_t \quad (4)$$

$$dSE_t = c_3 + \pi_{31} dSE_{t-4} + \pi_{32} dTheil_{t-4} + \pi_{33} dFDI_{t-4} + \pi_{34} dTO_{t-4} + \pi_{35} dGDP_{t-4} + \varepsilon_t \quad (5)$$

$$dTO_t = c_4 + \pi_{41} dTO_{t-4} + \pi_{42} dTheil_{t-4} + \pi_{43} dFDI_{t-4} + \pi_{44} dSE_{t-4} + \pi_{55} dGDP_{t-4} + \varepsilon_t \quad (6)$$

$$dGDP_t = c_5 + \pi_{55} dGDP_{t-4} + + \pi_{52} dTheil_{t-4} + \pi_{53} dFDI_{t-4} + \pi_{54} dSE_{t-4} + \pi_{55} dTO_{t-4} + + \varepsilon_t \quad (7)$$

The table 4 reports the regression results. The coefficient of *FDI*, the variable of interest, is estimated to be --.0000113 in lag (3), statistically significant at the five per cent level. Therefore, a one per cent increase of FDI results in a decrease of income inequality (Theil index) by 0.000113. more educated labor led to increase the wage inequality Egyptian industry sector, with the coefficient estimated to be .0021484 which is statistically significant at the five per cent level in lag (3). Trade openness (To) appears to increase wage inequality in Egyptian industry sector, with the estimated coefficient .0014468 in lag (1). the estimate of GDP coefficient is -.0003045in lag (1) and statistically significant at five percent, which means GDP appears to reduce wage inequality in the industry sector.

For the VAR model with (4) lags, we carried out the stability test to check from the stability condition of the VAR model, as shown from table 5, since all the eigenvalues lie inside the unit circle the VAR model

satisfies stability condition. Furthermore, we checked from the residual diagnostics. Particularly, we implemented a Lagrange multiplier (LM) test for autocorrelation in the residuals of VAR models, which was presented in Johansen (1995). The null hypothesis of the test is H0: no autocorrelation at lag order, since the p-value at the lag (4) as seen in table 6 is greater than 0.05, we cannot reject the null hypothesis which means that the model has not or does not suffer from autocorrelation problem.

<insert Table5 here>

<insert Table 6 here>

the causality relationship between the wage inequality (Theil index) and FDI in industry sector are examined by conducting Pairwise Granger causality tests after var to see if lagged value of Theil index helps to predict FDI. The null hypothesis test is that Theil index does not helps to predict future values of FDI, and the alternative hypothesis is that Theil index helps to predict future values of FDI. As seen in the table 7 p-value is 0.119 greater than 0.05 which means we accept the null hypothesis, Theil index does not help to predict future values of FDI, However, we found lagged value of FDI helps to predict Theil index. Therefore, The direction causality from FDI to Theil index.

<insert Table7 here>

The impulse response functions trace the time path of the effect of structural shocks to Theil index (wage inequality) in industry sector in response to a unit change in shock to FDI. Figure 4 shows a negative impact of the first difference of FDI on the first difference of Theil index and some positive impact in some years.

<insert figure4 here>

In our VAR model, we verified the variance decomposition of the wage inequality in industry sector (Theil index) using Cholesky factors as shown in table (8) basically, the Theil index is responding to the change in FDI. In the period (40), approximately 17% change in Theil index (wage inequality) due to the change in FDI, 46% change in Theil index due to change or shock in Theil index itself (own shock) and the remaining change in Theil index (37%) due to other independent variables.

<insert Table8 here>

6 Concluding remarks

In this paper, we try to evaluate the impact of FDI inflows, on domestic wage inequality within industry sector in the Egyptian economy through learning process as technology transfer from foreign firms to domestic firms. Based on a model of the impact of new technologies on wage inequality developed byAghion and Howitt (1998). Following Figini and Görg (1999); and Figini and Go¨ rg (2011) models for Ireland, and some selected developing and developed countries respectively.

In the econometric analysis we use Theil index as a proxy for wage inequality in industry sector in our VAR model for time series data over the period 1975-2014. According to the VIF test and the existence of the multicollinearity, we can not check from non-linear relationship between Theil index (wage inequality) and FDI inflows within the industry sector, However, we check from linear relationship between Theil index and FDI using VAR in difference model, which is suitable and useful model, when the variables included in the model are not exogenous. Our results indicate that, a one per cent increase of FDI results in a decrease of income inequality (Theil index) by 0.000113. which indicate that domestic firms may learning from foreign firms.

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Table 1variables definition and summary statistics

Variable	Definition	Mean	Std. Dev.	Min	Max
Theilindex	Theil index	.0694923	.0517756	.0097498	.1595839
FDI	FDI inflows in industry sector	1555.38	1144.923	127.27	4926.76
SE	The secondary school enrolment as a % of gross enrolment	67.77103	13.59737	38.82822	83.27793
To	(Imports + Exports)/GDP	51.81645	10.72697	35.33981	74.45958
GDP	GDP per capita (constant 2010US$)	1749.364	550.8978	803.0988	2649.448

Table 2 Unit Root Test Results

	Level		First difference		Second difference	
Variables	Constant	Constant + Trend	Constant	Constant + Trend	Constant	Constant + Trend
Theil index	-0.98	-3.336	-5.535	-5.456		
FDI	-2.051	-2.137	-4.575	-4.504		
GDP	-0.328	-2.35	-2.245	-2.204	-3.647	-3.603
To	-2.59	-2.892	-3.552	-3.527		
SE	-1.924	-1.986	-6.175	-6.51		

Note: ADF is the augmented Dickey Fuller test, The null hypothesis is that the series contains a unit root.

Table 3selection Lag criteria

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
dTheilindex						
dTheilindex						
L1.	.0114777	.1500307	0.08	0.939	-.282577	.3055324
L2.	-.2025852	.1499584	-1.35	0.177	-.4964982	.0913279
L3.	-.3416848	.1752254	-1.95	0.051	-.6851204	.0017507
L4.	-.0501242	.1415121	-0.35	0.723	-.3274829	.2272344
dFDI						
L1.	-8.89e-06	3.31e-06	-2.69	0.007	-.0000154	-2.41e-06
L2.	1.83e-06	4.09e-06	0.45	0.654	-6.18e-06	9.85e-06
L3.	-.0000113	3.13e-06	-3.62	0.000	-.0000175	-5.20e-06
L4.	-6.15e-06	3.70e-06	-1.66	0.096	-.0000134	1.09e-06
dSE						
L1.	-.0008191	.0007014	-1.17	0.243	-.0021937	.0005555
L2.	-.0017864	.0007036	-2.54	0.011	-.0031655	-.0004073
L3.	.0021484	.0007106	3.02	0.002	.0007557	.003541
L4.	-.0002978	.0007261	-0.41	0.682	-.001721	.0011254
dTo						
L1.	0014468	.0004332	3.34	0.001	.0005977	.0022958
L2.	-.0007527	.0005503	-1.37	0.171	-.0018314	-.0003259
L3.	.0000908	.0004626	0.20	0.844	-.0008158	.0009974
L4.	.0001487	.0003201	0.46	0.642	-.0004787	.0007762
dGDP						
L1.	-.0003045	.0001091	-2.79	0.005	-.0005183	-.0000907
L2.	.0001906	.0000978	1.95	0.051	-1.00e-06	.0003822
L3.	.0003196	.0000954	3.35	0.001	.0001325	.0005067
L4.	-.0002135	.0001404	-1.52	0.128	-.0004888	.0000618
_cons	.0084678	.0024928	3.40	0.001	.0035821	.0133536

Table 4 Estimation of dTheil index -dFDI VAR

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	-730.917				3.9e+11	40.8843	40.961	41.1042
1	-544.708	372.42	25	0.000	5.1e+07	31.9282	32.3888	33.2478*
2	-523.453	42.508	25	0.016	6.9e+07	31.1363	32.9807	34.5556
3	-493.196	60.515	25	0.000	6.5e+07	31.8442	33.0724	35.3631
4	-444.718	96.956*	25	0.000	2.9e+07*	30.5399*	32.1519*	35.1585

Table 5 the stability test of VAR model

Eigenvalue		Modules
.468768 +	.765613i	.897723
.468768 -	.765613i	.897723
.7163308 +	.5345316i	.893786
.7163308 -	.5345316i	.893786
-.04535289 +	.8658752i	.867062
-.04535289 -	.8658752i	.867062
-.8259926 +	.03715292i	.826828
-.8259926 -	.03715292i	.826828
-.2636912 +	.7731416i	.778264
-.2636912 -	.7731416i	.778264
-.4937823 +	.6015592i	.816873
-.4937823 -	.6015592i	.816873
.6420157 +	.4250674i	.778264
.6420157 -	.4250674i	.778264
.02726239 +	.5993246i	.769978
.02726239 -	.5993246i	.769978
-.4248195 +	.1394474i	.447121
-.4248195 -	.1394474i	.447121
.3403743		.340374
.1771888		.177189

Table 6 the Lagrange multiplier (LM) test

lag	Chi2	df	Prob>chi2
1	31.4200	25	0.17549
2	25.6482	25	0.42656
3	18.2396	25	0.83205
4	31.9722	25	0.15882

Note: H0: no autocorrelation at lag order

Table 7 Pairwise Granger causality tests Results

Equation	Excluded	chi2	df	Prob > chi2
dTheilindex	dFDI	19.453	4	0.001
dTheilindex	dSE	16.175	4	0.003
dTheilindex	dTo	12.524	4	0.014
dTheilindex	dGDP	22.087	4	0.000
dTheilindex	all	41.365	4	0.000
dFDI	dTheilindex	7.3314	4	0.119
dFDI	dSE	2.4413	4	0.655
dFDI	dTo	5.1673	4	0.271
dFDI	dGDP	24.075	4	0.000
dFDI	all	40.16	4	0.001

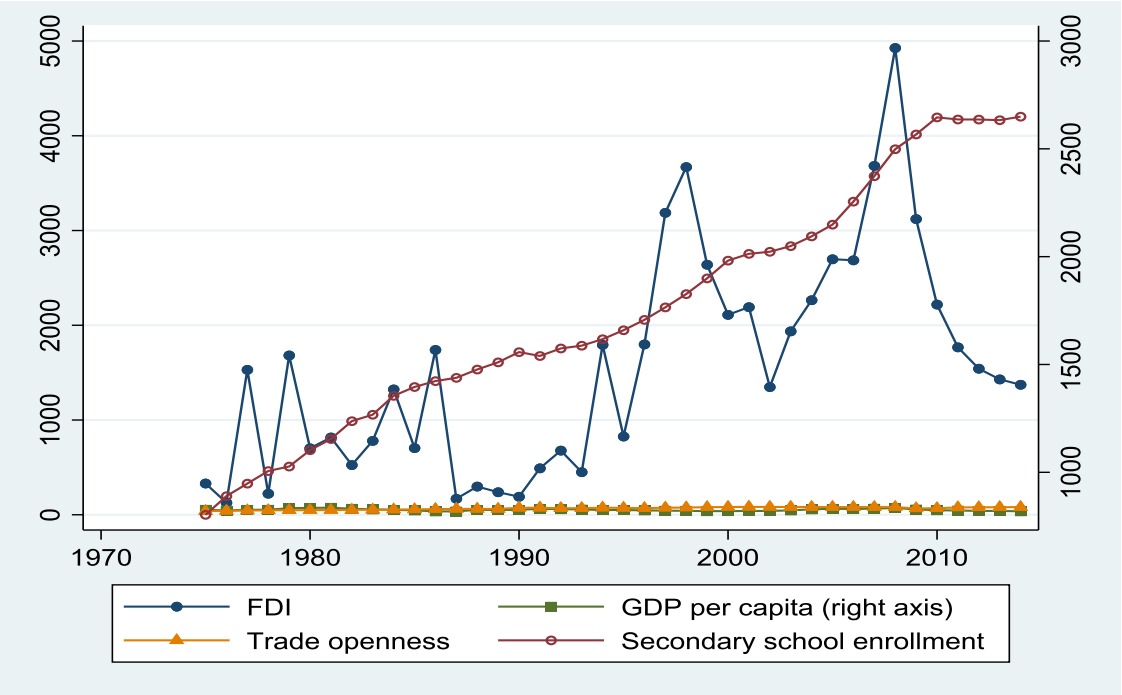
Note: The null hypothesis test is that Theil index does not helps to predict future values of FDI.

Table 8variance decomposition of Theil index

Period	dFDI	dTheilindex	dSE	dTo	dGDP
1	0	1	0	0	0
2	.177051	.617426	.007794	.08563	.112099
3	.166837	.605271	.006452	.121298	.100142
4	.152105	.549227	.072326	.11049	.115851
5	.143013	.521475	.085622	.140768	.109122
6	.154557	.503172	.079719	.160744	.101808
7	.150788	.503006	.090771	.15498	.100456
8	.15548	.497984	.096375	.153768	.096393

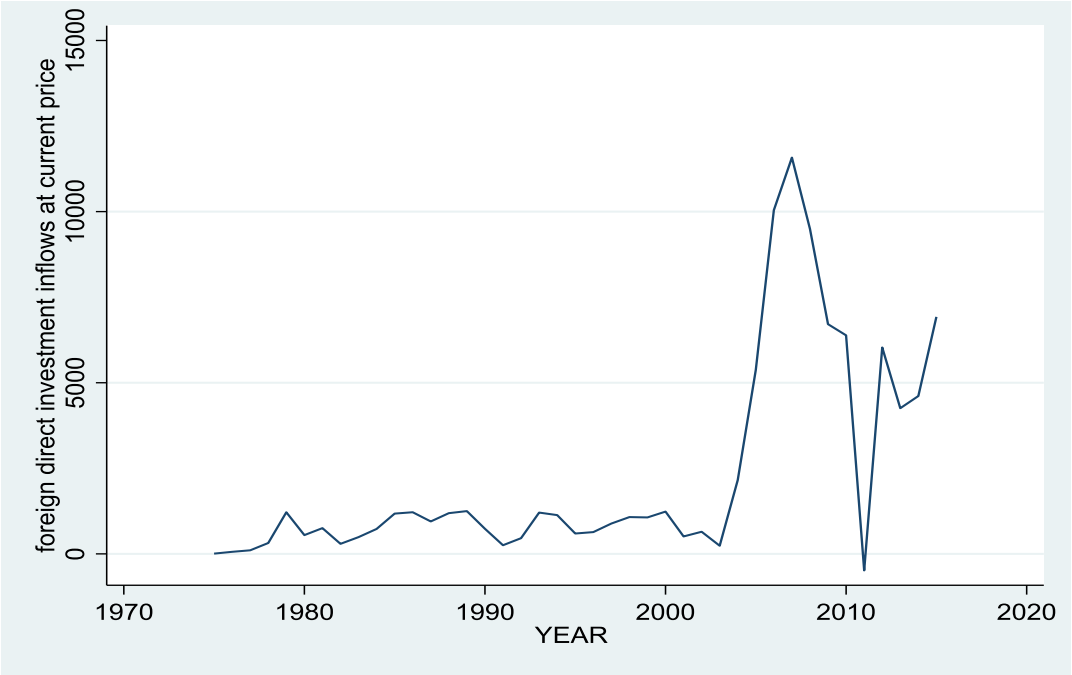
9	**.155131**	**.498539**	**.096808**	**.153501**	**.09602**
10	**.157589**	**488701**	**.099888**	**.150439**	**.103383**
11	**.156822**	**.487207**	**.100979**	**.15042**	**.104571**
12	**.155507**	**.483556**	**.100199**	**.149392**	**.111346**
13	**.155007**	**.480134**	**.100158**	**.148523**	**.116179**
14	**.161244**	**.475661**	**.099508**	**.1485**	**.115087**
15	**.163753**	**.472621**	**.098893**	**.150302**	**.114432**
16	**.164769**	**.471252**	**.100231**	**.149449**	**.1143**
17	**.16885**	**.465437**	**.100414**	**.150604**	**.114695**
18	**.169196**	**.463795**	**.10002**	**.152463**	**.114526**
19	**.168847**	**.463051**	**.1014**	**.152167**	**.114535**
20	**.168696**	**.462343**	**.102184**	**.152107**	**.114669**
21	**.169476**	**.46174**	**.102068**	**.152207**	**.114509**
22	**.169722**	**.461453**	**.102159**	**.152255**	**.114411**
23	**.169636**	**.461386**	**.102526**	**.152136**	**.114317**
24	**.169696**	**.461191**	**.102627**	**.152167**	**.114319**
25	**. 169667**	**.461111**	**.102633**	**.152204**	**.114384**
26	**.169682**	**.46102**	**.102742**	**.152198**	**.114357**
27	**.169653**	**.460965**	**.10274**	**.152259**	**.114383**
28	**.169684**	**.460874**	**.102745**	**.152231**	**.114465**
29	**.169777**	**.460705**	**.102746**	**.152272**	**.1145**
30	**.169805**	**.46065**	**.102733**	**.152324**	**.114488**
31	**.169794**	**.460598**	**.102763**	**.152304**	**.114541**
32	**.169855**	**.460471**	**.102777**	**.152291**	**.114605**
33	**.169936**	**.460387**	**.102759**	**.152326**	**.114592**
34	**.169938**	**.460356**	**.102775**	**.152341**	**.114591**
35	**.169945**	**.460324**	**.102811**	**.152327**	**.114592**
36	**.169992**	**.460272**	**.102811**	**.152342**	**.114583**
37	**.17**	**.460255**	**.10281**	**.152357**	**.114578**
38	**.169995**	**.460249**	**102831**	**.152351**	**.114574**
39	**.169996**	**.46024**	**.102839**	**.152354**	**.114571**
40	**.169997**	**.460238**	**.102838**	**.152356**	**.114571**

Figure 1 Time Series of Explanatory Variables



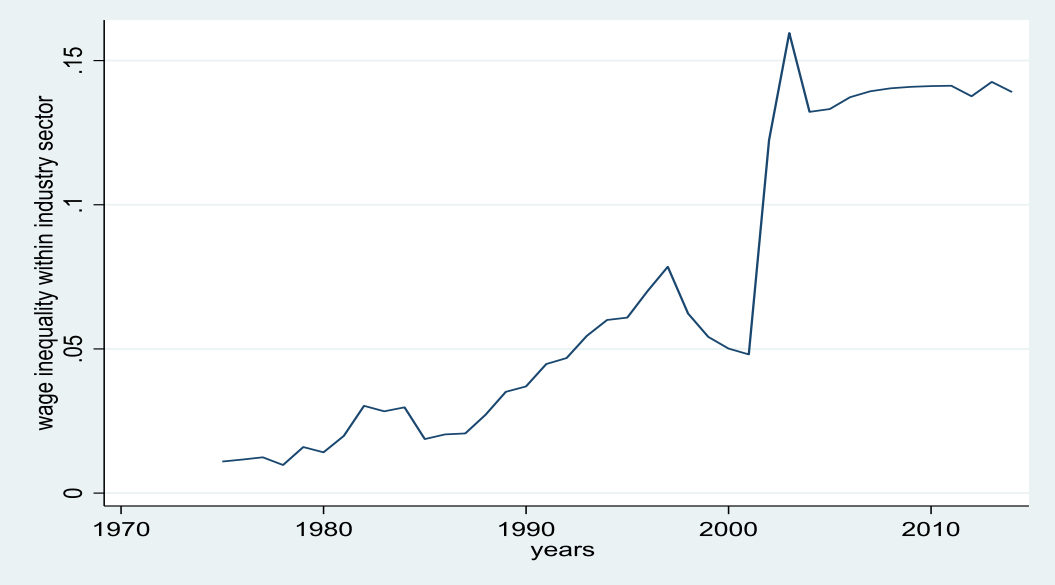
Source: World Bank and GAFI

Figure (2) FDI inflows in Egypt



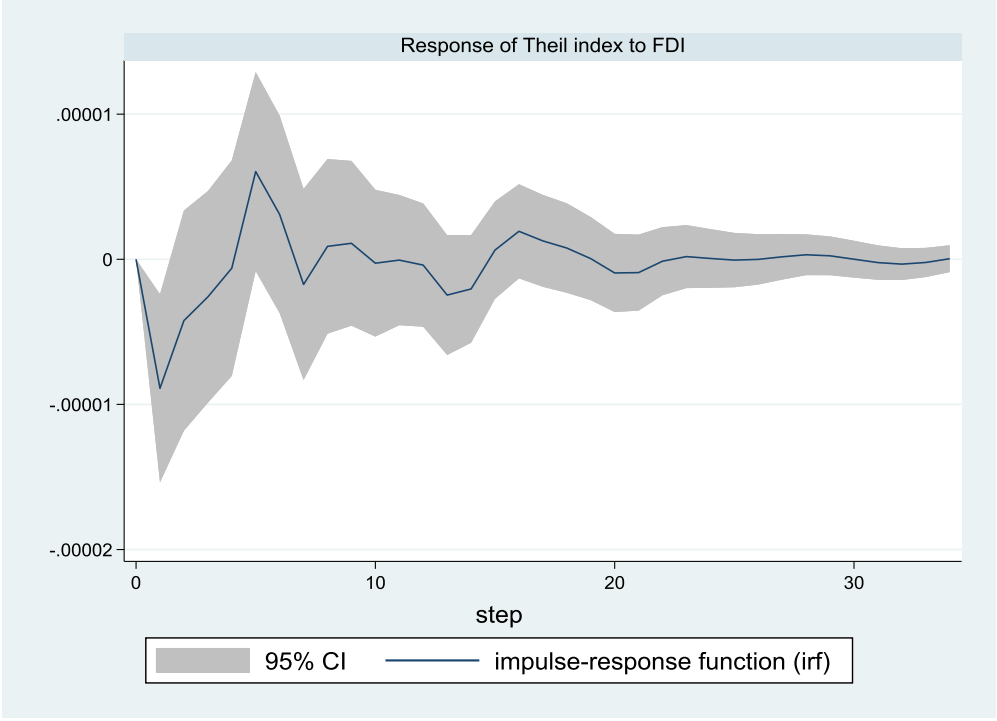
Source: UNCTAD database

Figure 3 wage inequality in industry sector



Source: the university of Texas inequality project

Figure 4impulse-response Function



الملخص:

في هذه الورقة ، نحاول تقييم تأثير تدفقات الاستثمار الأجنبي المباشر على عدم المساواة في الأجور المحلية داخل قطاع الصناعة في الاقتصاد المصري من خلال عملية التعلم مثل نقل التكنولوجيا من الشركات الأجنبية إلى الشركات المحلية. استنادًا إلى نموذج لتأثير التقنيات الجديدة على عدم المساواة في الأجور الذي طوره أغيون وهويت (1998). بعد فيجيني وجورج (1999) ؛ و Figini و 2011) Go¨ rg) لأيرلندا ، وبعض البلدان النامية والمتقدمة المختارة على التوالي.

في التحليل الاقتصادي القياسي ، نستخدم مؤشر ثيل كبديل لعدم المساواة في الأجور في قطاع الصناعة في نموذج VAR لبيانات السلاسل الزمنية خلال الفترة 1975-2014. وفقًا لاختبار VIF ووجود علاقة خطية متعددة ، لا يمكننا التحقق من العلاقة غير الخطية بين مؤشر Theil (عدم المساواة في الأجور) وتدفقات الاستثمار الأجنبي المباشر داخل قطاع الصناعة ، ومع ذلك ، فإننا نتحقق من العلاقة الخطية بين مؤشر Theil و FDI باستخدام VAR في نموذج الاختلاف ، وهو نموذج مناسب ومفيد ، عندما تكون المتغيرات المدرجة في النموذج غير خارجية. تشير نتائجنا إلى أن زيادة الاستثمار الأجنبي المباشر بنسبة 1٪ تؤدي إلى انخفاض في عدم المساواة في الدخل (مؤشر Theil) بمقدار 0.000113. مما يشير إلى أن الشركات المحلية قد تتعلم من الشركات الأجنبية

الكلمات الدالة: الاستثمار الأجنبي المباشر، عدم المساواة في الأجور، قطاع الصناعة، مصر.