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Dario D'Ingiullo[1] - Donatella Furia[2] - Iacopo Odoardi[3] - Davide Quaglione[4]

LOANS TO HOUSEHOLDS AND THE HUMAN CAPITAL EFFECT: DIFFERENCES BETWEEN NORTH AND SOUTH ITALY

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Abstract

The expansion of private credit after the 1990s led to increasing interest in the determinants of borrowing in a nation such as Italy, where households normally have a low propensity to accrue debt. Furthermore, this expansion of credit has stopped, as the post-crisis years have been characterized by a severe increase in credit constraints. In this absence of a consistent economic recovery, we investigate the ways in which human capital influences loans to households in Italian regions, also considering the differences in borrowing opportunities between the "wealthy" Center-North and the "poor" South. Our instrumental variables analysis suggests a positive role of second-level education in the Center-North, a substantially insufficient effect in the South, a negative condition for those engaged in lifelong learning (probably linked to precarious labor conditions) and contrasting aspects linked to the phenomena that weaken human capital. We also compare the effects on consumer credit (unsecured debt) and mortgages (for the purchase of real estate, secured debt).

JEL CLASSIFICATION: O15; E51
KEYWORDS: HOUSEHOLD LOANS; HUMAN CAPITAL; CONSUMER CREDIT; MORTGAGES

[1] University of Chieti-Pescara, Viale Pindaro 42, Pescara 65127, Italy; *E-mail address*: dario.dingiullo@unich.it.
[2] University of Chieti-Pescara, Viale Pindaro 42, Pescara 65127, Italy; *E-mail address*: donatella.furia@unich.it.
[3] University of Chieti-Pescara, Viale Pindaro 42, Pescara 65127, Italy; *E-mail address*: iacopo.odoardi@unich.it.
[4] University of Chieti-Pescara, Viale Pindaro 42, Pescara 65127, Italy; *E-mail address*: davide.quaglione@unich.it.

1. Introduction

Credit to households represents approximately half of private credit in many countries, and this share grows with the economic development of countries and their financial systems (Beck et al. 2012). Many scholars have focused on loans to households due to their rapid expansion before the 2007–2008 crisis (e.g., Backé and Wójcik 2008), while the reduction of credit continued until the so-called credit crunch occurred in several markets (e.g., Iyer et al. 2014, for further explanation see Brunnermeier 2009) after the crisis[5].

Access to credit depends on numerous factors linked to the supply and demand sides. The characteristics of both consumer households and local financial systems influence opportunities for access to credit. This paper investigates whether, in the period of instability following the recent financial crisis, a stable aspect that can favor access to credit and the qualitative composition of indebtedness is borrowers' level of human capital. Human capital, assessed through education levels, is positively associated with the level of household debt (Bolibok 2015), representing a typical factor influencing borrowing decisions and helping better define consumption needs (Magri 2002), also improving the understanding and skills linked to financial contracts (Disney and Gathergood 2013).

The interest in the study of household credit is controversial because the literature suggests that an increase in this type of credit could represent a predictor of bank crises (Büyükkarabacak and Valev 2010), whereas some positive effects may arise from the expansion of credit to households when these resources are used for investments in human capital (Galor and Zeira 1993).

With regard to credit constraints that generally limit access to credit (e.g., Jappelli 1990), a central question is whether human capital has played a determining role in influencing household access to credit during the credit crunch period in Italy.

This question becomes important in a country where the socioeconomic role of advanced education is ambiguous (Di Liberto 2008). In fact, we focus on human capital in this work for the following reasons: (*i*) It is a fundamental variable in socioeconomic analyses concerning debt expectations (Section 2.2), and (*ii*) higher education levels can have different influences on borrowing opportunities (Mitrakos and Simigiannis 2009), as we consider

[5] In some countries, the interruption of the pre-crisis trend of greater credit availability has contributed negatively to post-crisis living conditions (Montagnoli and Moro 2018).

several variables to depict the multidimensional value of human capital. (*iii*) The level of human capital in Italy has historically been lower than in other advanced economies (Wolff 2000), and educational gaps have been confirmed in recent years (OECD 2018), proved, for example, by a low return on education (Ballarino and Scherer 2013), thus discouraging further investments in higher education. (*iv*) Its role in the Italian economy is weaker than that observed in other advanced economies; for example, it does not represent a consistent support for economic development (Odoardi and Muratore 2018), and sometimes the lower levels of education are the most relevant (Di Liberto 2008), and, as a result, we expect that its role in supporting access to credit will be weak. (*v*) Qualitative and quantitative aspects of human capital differ between the (rich) North and the (relatively poor) South of the country (Piffer and Lynn 2014; Abramo et al. 2016); thus, we expect a greater effect in the northern regions.

The last point raises a second question: Does the role of education in access to credit differ by region?

In fact, regional heterogeneity and the North-South divide have roles in the different levels of efficiency of local financial systems in Italy, and structural weaknesses are evident in the southern area (Ferri and Messori 2000). The South is also at risk of high costs in financing processes due to the rising risk of default (Del Giovane et al. 2013). For these reasons, we analyze the two main macro areas (Center-North and Mezzogiorno, i.e., the southern area, see Brida et al. 2014), as are often considered in analyses of credit in Italy (e.g., Angelini et al. 1998; Presbitero et al. 2014), because a proper regional division seems to be an essential step in Italian regional analyses (Terrasi 1999).

The analysis is carried out on the average household debt and on two subcategories for the period 2004–2014[6], which according to their characteristics and uses may show differences between the two areas, also considering in the analysis the risk of reverse causality between the loan values and the proxies of human capital. We consider consumer credit (unsecured debt) and mortgages (for the purchase of real estate, secured debt, as similarly done by Ottaviani and Vandone 2011)[7]. The differences are due

[6] This period represents a compromise among the many variables composing the dataset and the availability of regional data.

[7] Huston (2012) also considers the effect of financial literacy on the cost of borrowing considering credit cards and mortgages in the US.

to the loans' nature (e.g., need for collateral, and therefore foreclosure for some subjects) and accessibility (e.g., ease of using consumer credit)[8].

Additionally, we expect that the location of the debtor is influential (Cannari and Ferri 1997) for the different types of loans (e.g., the average income in the North is almost double that in the South, according to Istat data, the Italian National Institute of Statistics) and for factors affecting access to credit and amounts borrowed.

Economic literature usually observes household loans as a transmission mechanism of monetary policy (Li 2000), studying their effects on economic growth and income distribution (Beck et al. 2012) or their role in banking crises (Büyükkarabacak and Valev 2010). On the other hand, the determinants of borrowing are often considered according to corporate credit (e.g., Bhaduri 2002; Hackbarth 2009) and more rarely household credit (Nieto 2007).

This work contributes to the broadest area of research on household credit by supporting the understanding of credit determinants that can inform predictions of the effects of financial decisions and, indirectly, consequences for local development. For this reason, policymakers give great importance to the analysis of the composition of financial portfolios at the household level (Brown et al. 2015). In addition, a positive effect of (advanced) education on credit is doubly desirable in the Italian case. First, it would also improve the qualitative composition of debt (in terms of costs; see Huston 2012) and allow greater access to credit. Second, it would encourage further investment in education and training in a country where this has historically received little consideration (Wolff 2000).

We investigate a period that includes the 2007–2008 crisis and the post-crisis years[9], which are characterized by increasing instability in the financial markets at the international level (Bonamini et al. 2015), contributing in Italy to a prolonged recession that followed a period of economic decline (Tridico 2015), restricting access to credit (Girardi and Ventura 2019). The analysis of this period can be useful in providing suggestions for policy in conditions of instability and severity.

The original aspects of this paper are the consideration of human capital observed at different levels (since Mitrakos and Simigiannis (2009) found different effects in Greece) in a regional analysis and the comparison of

[8] In addition, both consumption and house purchase are means by which loans to households have an effect on GDP (Barone et al. 2018).

[9] Before the financial crisis, for example, Coricelli et al. (2006) explained strong credit growth for households in Europe in a context of weakening liquidity constraints due to the changing supply-side conditions and the positive outlook for income growth.

different types of loans that, by their nature, play different roles in a country characterized by a strong socioeconomic dualism between North and South.

The paper is organized as follows. We describe several factors in households' decision to borrow in Section 2. After explaining the methods of the analysis in Section 3, we describe the variables used in Section 4. We propose the model results in Section 5. In the concluding section, we suggest policy interventions, comparing our results with the specific literature while considering the Italian North-South dualism.

2. Literature survey

The interest in economic studies of private credit depends on its increasing economic role. On one hand, an increase in credit to the private sector can be useful in stimulating economic growth (King and Levine 1993; Beck et al. 2000; Levine et al. 2000; Benhabib and Spiegel 2000; Badunenko and Romero-Ávila 2013). On the other hand, the rapid and uncontrolled growth of private credit is associated with negative financial consequences and crises (Jorda et al. 2011; Schularick and Taylor 2012). According to Büyükkarabacak and Krause (2009), a high level of private credit means more developed financial systems and implies easier access to credit for both households and businesses. Thus, a high level of private credit can bring economic benefits, while rapid growth poses risks (Angeles 2015). Of course, differences exist in types of loans, for example, by distinguishing between the short and long terms (Loayza and Ranciere 2006) or the different roles of households and corporate credit (Angeles 2015).

Within private credit, household loans were less important than corporate credit before the 1990s, but their share of total private credit has increased in recent years (Zinman 2009). However, household loans are on average lower, with less collateral and difficulty in assessing the risk linked to the household increasing the information asymmetries (Beck et al. 2012). Considering the possible types of borrowers, credit to households is a prevalent consumer stimulus that has less impact on long-term economic growth; conversely, lending to businesses contributes to increasing the capital endowment and productivity of the economic system (Büyükkarabacak and Valev 2010). For example, Aghion et al. (2005) test the positive relationship between the grant of greater credit to businesses and the growing convergence of economic systems toward the technological frontier, while Sassi and Gasmi (2014) demonstrate (in 27 European countries) the direct relationship between credit to business and GDP growth and the opposite negative relation with the expansion of credit to households. Thus, the usefulness of the latter type is in

the transmission of monetary policies, which helps explain the direct correlations among the role of money, credit services and the real economy over the course of the economic cycle (Li 2000).

2.1. Human capital, borrowing choices and opportunities

The relationship between debt and human capital is studied in economic literature following diverse approaches. For example, considering credit constraints, the possibility of borrowing represents potential access to advanced education, i.e., of investing in human capital (among others, Becker and Tomes 1979 and 1986; Stevens 1999; Heckman 2005; Lochner and Monge-Naranjo 2011). Education level can also represent information by which banks select borrowers based on risk (Bates 1990; Chaudhary and Ishfaq 2003; Bruns et al. 2008), with higher levels being linked, for example, to higher earnings or greater ability to succeed in business. On the other hand, education affects both quantitative and qualitative choices on loan applications (Hullgren and Söderberg 2013) that are based, among other aspects, on understanding economic and financial aspects (e.g., Bucks and Pence 2008). For Magri (2002, p. 3), "*Education influences both the demand side, through entry costs, and banks' evaluation*."

In a broader perspective, the aim of explaining choices and motivations to consume, save and borrow is common in the literature and among policymakers (Brown et al. 2005; Amari 2014), starting from the themes of the *Life-Cycle Theory* (Modigliani and Brumberg 1954; Modigliani 1986) and the *Permanent Income Hypothesis* (Friedman 1957). Typically, expected lifetime income and wealth, real interest rates and demographic factors are considered to affect opportunities and decisions to save and borrow. Human capital, influenced by education and vocational training paths (Becker 1962), also impacts on opportunities and choices to borrow. The direct relationship between advanced education and borrowing opportunities (Zhu and Meeks 1994; Mitrakos and Simigiannis 2009) is due to greater possible future income and better understanding of financial terms and conditions (Georgarakos et al. 2010). Human capital in general is also positively related to a sort of financial knowledge (Lusardi and Mitchell 2007). As in Huston (2012, p. 566), "*People with more knowledge and skills (human capital) have the ability to more efficiently search for lower borrowing rates. Financial knowledge may also improve a borrower's ability to manage credit, making them more attractive to lenders*." Positive effects exist from literacy (Dzadze et al. 2012), improving with higher education (Grimes et al. 2010), up to actual financial literacy (see Huston 2010; van Rooij et al. 2011). For example, Dynan and

Kohn (2007) find that households with higher education levels borrow at young ages, and the average increase in education in the US could help explain the long-term growth in debt.

According to Magri (2002), education helps detect "entry costs" in the debt market, and several studies prove that less educated people are at greater risk of falling into financial distress and, in some cases, becoming overly indebted (Lusardi and Tufano 2009). Knowledge and awareness (in general and of the financial markets) also affect individuals' choices and allow for better calibration and choices of loans. Greater understanding of the effects of financial choices is important in an increasingly complex context in which technology has amplified financial services and accessibility (Greenspan 2005). Financial illiteracy, on the other hand, can induce wrong choices when households can choose different levels of indebtedness (e.g., Brunnermeier and Julliard 2008) up to foreclosure relationships with banks (Grimes et al. 2010).

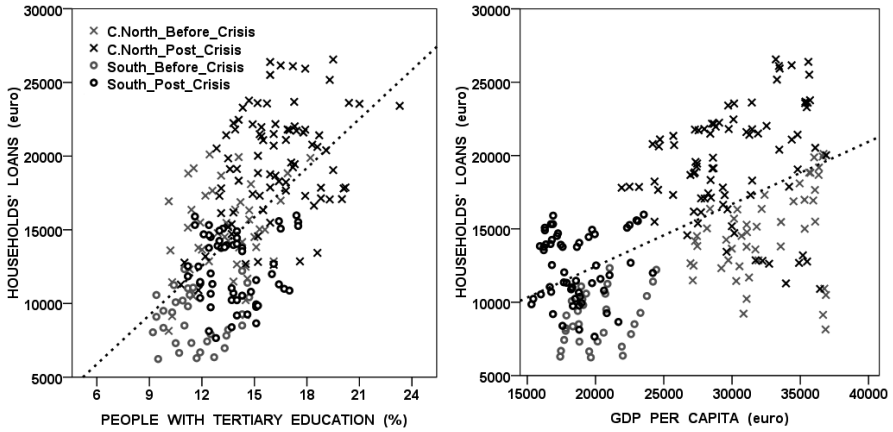
2.2. Some facts on the Italian regional context

The average indebtedness of Italian households was historically lower than in other Western countries at least until the early 2000s, when it began to grow at rates above the European average (Bank of Italy 2010). In the years after the 2007–2008 crisis, in contrast, the percentage of indebted households decreased due to limits and difficulties on both the demand and supply sides (Magri and Pico 2012). As in many other countries, the credit boom prior to the crisis was one of the causes of credit contraction in subsequent years (Aisen and Franken 2010). This contraction has entailed difficulties for both businesses and families in obtaining credit, at least in the short term (Barone et al. 2011), and for those mainly linked to Italian banks most exposed to the interbank market (Bonaccorsi di Patti and Sette 2012).

In terms of the average loan value, post-crisis values are higher than before (on Istat data, Figure 1), despite the many obstructions to the growth rate of household loans in this period (Magri and Pico 2012). In particular, the post-crisis increase, occurring in the South in a context of rising unemployment, was strongly influenced by the growth of consumer credit (on Bank of Italy data). In contrast, the incidence of mortgages has increased for some northern regions characterized by higher incomes (Vacca et al. 2013).

We show some regional differences in Figure 1, in which we highlight both the territorial dualism and the pre- and post-crisis frameworks; each sign represents the value of a year for a region.

Figure 1. Relationships among some determinants influencing borrowing opportunities and average loans per household in the Italian regions for the 2004–2014 period.



Source: Authors' elaborations on Bank of Italy, Eurostat and Istat data.

In Figure 1, social and economic variables confirm the dualism in the endowment of human capital, credit and income. The North-South differences are due to the different efficiencies characterizing the local financial systems, and decades of studies have demonstrated the direct relation of efficiency to economic development (Zago and Dongili 2011). A strong divergence began in the 1990s, when the greatest liberalization and privatization of the banking system occurred. The slight recovery of the southern regions was significantly hindered after the 2007 crisis due to the distance between the seats of the banks (usually in the North) and the most peripheral areas (Sette and Gobbi 2015). These "distance" effects due to bank branches located in the South being owned by banks located in the more financially developed northern area are also observed by Presbitero et al. (2014).

The rationing of credit and the tightening of access conditions were among the crisis consequences (Panetta and Signoretti 2010), and the structurally weakest areas (southern regions) have been the most affected. At the same time, the greatest dependence on external finance in the Center-North has brought effects (especially for small businesses) in this area (Barone et al. 2017).

Finally, North-South differences are evident in the destinations of private

credit. In the period 2012–2014, Italian consumer households received 27.25% of the total bank loans, with the public administration receiving 14.34% and businesses 58.41% (our elaborations on data from the Statistical Bulletin of Bank of Italy[10]). In the South, the share of loans to households is much higher than in the Center-North, equaling the share intended for businesses (Mattoscio et al. 2017).

3. Method

We use a fixed effects model (FE) to find relationships between variables within groups (see Elhorst 2014). FE is usually used in regional analyses (Ramos et al. 2010; Dall'Erba and Fang 2015) and on credit (e.g., Pitt and Khandker 1998 use a fixed effects model to investigate the credit eligibility of Bangladesh households; Keese 2009 uses FE to analyze different types of debt, consumer credit and home loans with German data), and it seems the most appropriate model for our case because all the regions are considered and the number of regions is small. The analysis is repeated for the three dependent variables. Our equation can be written as follows:

$$lnHD_{it} = \beta_1 lnEDUSEC_{it} + \beta_2 lnEDUTER_{it} + \beta_3 lnLIFEL_{it} + \beta_4 lnDROPOUT_{it} + \beta_5 lnNEET_{it} + \beta_6 UNEMPL_{it} + \beta_7 RATE_{it} + \beta_8 lnGDPH_{it} + \beta_9 lnWEALTH_{it} + \beta_{10} AGE_{it} + \beta_{11} SIZE_{it} + \alpha_i + \varepsilon_{it} \quad (1)$$

where HD denotes the three dependent variables representative of household debt (average loans, mortgages and consumer credit); $EDUSEC, \dots, NEET$ are the regressor proxies of human capital, followed by the control variables (Table 1). The data are on the Italian regions (i) for the 11-year period 2004–2014 (t). Finally, $\beta_1, \dots, \beta_{11}$ are the coefficients estimated in Section 5, α_i is the unknown intercept for each region and the error term is ε_{it}.

In the first analysis, the 20 Italian regions are considered, followed by the Center-North vs. South comparison. The first group includes 12 regions (those of the North-West, North-East and Center areas according to the Eurostat NUTS-1[11] classification), and the second group includes 8 regions (South and Islands).

[10] https://www.bancaditalia.it/pubblicazioni/bollettino-statistico/ Retrieved on 30 July 2019.
[11] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:02003R1059-20180118&qid=1519136585935 Retrieved on 30 July 2019.

However, the potential endogeneity due to the reverse causality between debt values and the proxies of education (EDUSEC and EDUTER) could result in biased estimates. A higher level of education can allow greater access to credit; it is also possible to borrow to invest in education (Section 2.1). To address this issue, we adopt an instrumental variable approach (two-stage least squares procedure, 2SLS) aimed at obtaining an exogenous variation in human capital through valid proxies that are correlated with the endogenous variables but not with the error terms. However, although the most common approach is to consider the economic literature for the choice of these external instruments, in the presence of some missing data, lagged instrumented variables and exogenous regressors may be used. For this reason, we decide to adopt the first and second lags of the endogenous variables and the exogenous regressors included in the main equation (Hsiao 2003).

4. Data

We consider three variables to represent household debt, i.e., average loans to consumer households and two subcategories. With the aim of estimating a proxy of the regional average household debt, we divide the total bank loans targeted at this category for the number of resident households. In the same manner, and considering the amounts of consumer credit and the medium- to long-term loans for the purchase of real estate (by households), we obtain proxies for the average regional indebtedness of unsecured debt and secured debt.

The economic literature explains household debt choices mainly by socioeconomic and demographic factors, such as income (and/or wealth), age, education and work status.

We represent human capital from three points of view:

(i) The secondary (EDUSEC) and tertiary (EDUTER) education levels (data on schooling are used by Breton 2013; Hanushek 2013) represent the different levels of education that influence the families' ability in different measures, such as choosing to enter financial contracts or deciding on forms of indebtedness, because higher degrees of education have different economic effects (Blöndal et al. 2003);

(ii) The percentage of adult persons involved in lifelong learning at the time of the survey (Jakobi and Rusconi 2009) represents the current

commitment to updating skills and knowledge, regardless of the level of study, an aspect not fully developed in the Italian context[12];

(iii) Finally, two aspects that negatively affect human capital are the school dropout rate and the NEET rate (young people not in education, employment or training)[13], referring to the deterioration of human capital and degree of inactivity of young people, which are particularly serious in the Italian context (see Mussida and Sciulli 2018, for the recessionary effects see Bell and Blanchflower 2011).

Education is considered the most consistent measure of human capital in regional studies (Gennaioli et al. 2013). We expect a positive effect on the growth of education (therefore a higher coefficient for tertiary education).

We control for a series of variables usually related to opportunities for borrowing and debt decisions of households. As Ottaviani and Vandone (2011, p. 755) state: "*The variables normally used to find the drivers of household debt demand are typically classified by socio-demographic variables (*e.g.*, age, gender, level of education, size of family, and geographical area) and economic variables (*e.g.*, net wealth, income, and work status)*."

In this study, we consider GDP per household (GDPH, Table 1) and household net worth (WEALTH) as uniform proxies of income and wealth levels at the household level. The latter variables (with the interest rate) are considered among the most important in explaining household debt (Magri 2002, for Italy; Tudela and Young 2005, for the UK). Nieto (2007, on Spanish households) finds that gross wealth represents one of the most important factors positively influencing the borrowing process, while the unemployment rate and the cost of loans are among the negative factors. The relationship between net wealth and debt level is tested by King and Leape (1998) and should have a negative impact on consumer credit (Magri 2007). Household wealth is also important because relevant transfers take place at the family level, not just as a support for young adults, in many advanced economies (Cigno et al. 2006). These transfers may be relevant in a credit-rationing context.

The unemployment level (UNEMPL) is a measure of the labor market representative of the Italian regional dualism. It is a variable related to income, but in contrast to the interest rate, it influences only a part of the population

[12] In 2014, the percentage of the adult population (25–64 years old) participating in education and training (last 4 weeks, Eurostat data and definition) was 8.1%, and the EU average was 10.8%.

[13] The variables related to human capital are obtained from the Istat (the Italian Institute of Statistics) database 'Istruzione-Formazione' (Education-Training) and Eurostat 'Regional Education Statistics.'

(Debelle 2004). Ottaviani and Vandone (2011) find that unemployed people tend to have both fewer mortgages and less consumer credit. We also include the Istat variable representing the efficiency of local financial systems (RATE) by calculating the difference between the average interest rate paid in each region with respect to the rates applied in the most "efficient" area of the country (i.e., the central-northern area). This is the extra cost that is paid in the less efficient areas (Angelini et al. 1998). The increase in the cost of credit also assumes relevance in light of the effects of the sovereign debt crisis in Italy (Bofondi et al. 2013).

Considering that the debtor's age influences access to credit, we consider the regional average age (AGE) as, for example, Magri (2007), finds that age acts as an important demand factor in Italian households, as do net wealth and income. Age is also a proxy for experience in making financial decisions (Huston 2012). Finally, we consider the average number of members per family for each region (SIZE) because Brown and Taylor (2008), in a study on the UK, the US and Germany, find that household size has an influence on indebtedness level.

We provide the definitions of the variables in Table 1; variables 1–3 are dependent variables, 4–8 represent human capital, and 9–14 are the control variables.

Table 1. Variable descriptions and sources.

	Variable	*Definition*	*Source*
1	LOANS	Total loans to consumer households divided by the number of residential households (euro)	*Bank of Italy and Istat (our elaborations)*
2	MORTG	Loans (over the short term) for purchases of real estate by consumer households (facilitated and not facilitated) divided by the number of residential households (euro)	*Bank of Italy and Istat (our elaborations)*
3	CONS_CR	Total consumer credit divided by the number of residential households (euro)	*Bank of Italy and Istat (our elaborations)*
4	EDUSEC	Population aged 25-64 with upper secondary and post-secondary non-	*Eurostat*

		tertiary education (levels 3-4 ISCED 2011[a], %)	
5	EDUTER	Population aged 25-64 with tertiary education (levels 5-8 ISCED 2011, %)	*Eurostat*
6	LLL	Population aged 25-64 participating in lifelong learning (attending a course of study or professional training) (%)	*Istat*
7	DROPOUT	School dropout rate, early leavers of education and training, % of population aged 18-24 with at most a secondary school education, and who have not completed a training course recognized by the region with a duration of more than 2 years and who do not attend school courses or training (%)	*Istat*
8	NEET	Young people aged 15-29 not in education and training (%)	*Istat*
9	GDPH	GDP per household, constant 2010 values (euro)	*Istat (our elaborations)*
10	WEALTH	Households' net worth (financial assets + real assets - financial liabilities) divided by the number of residential households (euro)	*Bank of Italy and Istat (our elaborations)*
11	UNEMPL	Unemployment rate (15 years and over, %)	*Istat*
12	RATE	Differential in lending rates on loan facilities in the Italian regions compared to the most efficient area (the Center-North average); the lending rates are on total cash loans (self-liquidating, term, and revocable liabilities) disaggregated by the locations of customers and by the duration of the rate (up to 1 year) referred to producer households and non-financial businesses	*Istat*
13	AGE	Average age of the population (years)	*Istat*

14	SIZE	Average number of components per family	*Istat*

[a] International Standard Classification of Education.

Table 2 presents a statistical summary of the variables listed in Table 1 for the two main macro areas. The regions composing the Center-North[14] and the South have historically diverged in many socioeconomic aspects (Romagnoli 2014), and the average data confirm the dualism in the analyzed period.

In Table 2, some aspects characterizing the Italian North-South divide are evident: economic dualism (the average income and wealth of the Center-North are more than 150% those of the South), social situation (the unemployment rate in the South is double that of the North) and financial efficiency (the average rates in the South are almost 1% above those in the Center-North area).

Table 2. Summary statistics (2004–2014).

		Min	Max	Mean	SD
		Dependent variables			
LOANS	C.-North	8143.73	26556.52	17715.01	4183.97
	South	6233.69	15975.05	11142.58	2698.40
MORTG	C.-North	4597.06	17507.68	10458.92	2871.24
	South	1827.82	9311.94	5494.56	1862.03
CONS_CR	C.-North	1434.89	5559.67	3435.50	810.99
	South	2177.93	6265.03	4420.82	926.50
		Independent variables			
EDUSEC	C.-North	34.80	51.14	42.71	3.21
	South	29.50	47.60	36.43	4.09
EDUTER	C.-North	10.10	23.30	15.12	2.64
	South	9.20	17.50	13.05	2.01
LLL	C.-North	3.89	12.13	6.82	1.37
	South	4.32	9.70	6.01	0.98

[14] There are 12 central-northern regions and 8 in the southern area.

DROPOUT	C.-North	8.39	26.12	15.95	3.34
	South	9.62	32.44	20.08	5.76
NEET	C.-North	8.67	24.31	14.66	3.49
	South	13.89	40.28	27.79	6.13
UNEMPL	C.-North	2.75	12.51	6.00	2.30
	South	6.16	23.42	13.37	3.83
RATE	C.-North	-0.49	0.63	0.08	0.22
	South	0.24	1.74	0.90	0.31
GDPH	C.-North	51207.42	88521.73	70659.94	9223.44
	South	37856.04	61336.67	49063.96	5518.35
WEALTH	C.-North	236830.22	634770.46	417491.67	92850.56
	South	165289.89	338171.40	258646.03	36417.68
AGE	C.-North	40.90	48.10	44.57	1.54
	South	38.30	45.50	42.33	1.68
SIZE	C.-North	1.97	2.60	2.29	0.14
	South	2.30	2.90	2.57	0.14

Source: Authors' elaborations on Bank of Italy, Eurostat and Istat data.

Level of education, whose North-South convergence is considered one of the main achievements of the unification of the country (Felice 2007), still shows a relative backwardness in the South, also comparing Italy to the European average (29% of the population with tertiary education in the EU, Eurostat data).

Financial efficiency induces greater credit availability in the North (see LOANS), while consumer credit represents a fast and directly accessible way to obtain the resources for consumption that are exploited in the South.

We observe the anomalous case of the highest average consumer credit in the South; this suggests that although consumer credit should characterize an alternative style of consumption, it probably influences a sort of demonstration effect (James 1987; Fisher 2004) in the southern case in a period of rising unemployment.

Regarding credit data, we must consider that the post-crisis drop in the Italian credit market was mostly due to the decline in mortgages and was particularly influenced by income and type of employment (self-employment is the most at-risk category), while consumer credit remained stable and

increased for less wealthy households or those that suffered a decrease in income (Magri and Pico 2012).

5. Results

Tables 3–5 show the results of the FE and 2SLS regressions considering the average loans per household and the two subcategories of mortgages and consumer credit. In each table, we present the results for Italy (all regions) and the two macro areas.

Table 3. Average loans: Panel data analysis for Italy and the two macro areas.

	Italy		Center-North		South	
	FE	2SLS	FE	2SLS	FE	2SLS
lnEDUSEC	0.5239	1.1030***	0.441	1.5143***	0.5497**	0.2404
	(0.3059)	(0.3942)	(0.4218)	(0.5046)	(0.1709)	(0.4385)
lnEDUTER	0.3578***	-0.1254	0.2873**	0.0887	-0.0538	-0.6868*
	(0.1163)	(0.2277)	(0.1254)	(0.2086)	(0.0960)	(0.3993)
lnLLL	-0.2169***	-0.1419**	-0.2024***	-0.2626***	-0.3840***	-0.2568***
	(0.0496)	(0.0583)	(0.0491)	(0.0720)	(0.0637)	(0.0991)
lnDROPOUT	-0.0577	0.0254	0.0206	0.1302*	-0.1613**	-0.1905***
	(0.0565)	(0.0696)	(0.0737)	(0.0709)	(0.0635)	(0.0656)
lnNEET	0.2789***	0.3418***	0.3126**	0.1993**	-0.1124	-0.0704
	(0.0797)	(0.0693)	(0.1202)	(0.1004)	(0.1131)	(0.1203)
UNEMPL	-0.0170***	-0.0260***	-0.0041	0.0117	-0.0191***	-0.0209***
	(0.0043)	(0.0045)	(0.0130)	(0.0135)	(0.0052)	(0.0049)
RATE	0.0592	0.0842	0.096	0.1735***	-0.0258	-0.0101
	(0.0546)	(0.0537)	(0.0823)	(0.0604)	(0.0582)	(0.0382)
lnGDPH	-0.3903	-0.3084	-0.0358	0.3339	-0.5378	-0.4447
	(0.2766)	(0.2375)	(0.2754)	(0.2682)	(0.3334)	(0.3642)
lnWEALTH	0.3879**	-0.1393	0.5603**	-0.2106	0.0126	-0.0897
	(0.1508)	(0.2441)	(0.1814)	(0.2519)	(0.1455)	(0.2766)
AGE	0.0363	0.1343***	0.0557	0.0798	0.1359*	0.2216***
	(0.0371)	(0.0442)	(0.0612)	(0.0571)	(0.0588)	(0.0621)
SIZE	-0.3564**	-0.1361	-0.4343**	-0.1303	-0.3598	-0.3538**
	(0.1533)	(0.1498)	(0.1624)	(0.1934)	(0.1914)	(0.1661)
Constant	5.1979		-1.4884		10.0844**	
	(4.3962)		(5.3202)		(4.1294)	
NT	220	180	132	108	88	72

N	20	20	12	12	8	8
R^2	0.873	0.778	0.862	0.782	0.934	0.859

Note: p<0.1*, p<0.05**, p<0.01***.

Source: Authors' elaboration based on Bank of Italy, Eurostat and Istat data.

Table 3 shows that human capital, observed as the education level of the population, can have a positive effect in allowing greater access to credit but only in the more developed regions. In the macroarea of the Center-North, the endowment of human capital makes it possible to constitute an average level able to create positive spillovers that instead in the South, where this level is not reached, induce a negative sign in the contribution of EDUTER (IV regression).

This difference confirms the qualitative and quantitative gaps of the South in terms of human capital (e.g., Abramo et al. 2016), also disadvantaging the southern regions in access to credit, an important resource in the recessive period.

In contrast, the inverse relationship of lifelong learning is uniform in all the regions. Causes may be found in the composition of this variable, which includes employed and unoccupied persons engaged in vocational (or pre-vocational) training that may cause high uncertainty about future working conditions.

Notably, early school dropout is relevant in the South, obviously with a negative sign, because this phenomenon affects the weaker social categories and areas where social welfare is more fragile (Di Pietro 2002).

Conversely, the NEET rate, which is a growing socioeconomic phenomenon strongly influenced by the 2007 crisis, has relevance in the North. Although the absolute values of NEET are higher in the South (35.8% in 2014, 19.9% in the Center-North), the changes were much stronger in the Center-North (with average increases of 4.85% and 2.04% in the South during the 2004–2014 period).

With increasing age, financial experience seems important only in the South, where even families, on average larger than in the rest of the country, have weight in accessing credit.

	Italy		Center-North		South	
	FE	2SLS	FE	2SLS	FE	2SLS
lnEDUSEC	0.6654**	1.2428**	0.6161	1.6967***	0.4017**	0.0274
	(0.2884)	(0.5089)	(0.4091)	(0.5781)	(0.1500)	(0.5358)
lnEDUTER	0.4737***	-0.1216	0.4175**	0.2939	-0.0197	-0.9521*
	(0.1473)	(0.2914)	(0.1756)	(0.2416)	(0.1489)	(0.5068)
lnLLL	-0.2973***	-0.2093***	-0.2266***	-0.3062***	-0.5237***	-0.3701***
	(0.0616)	(0.0642)	(0.0667)	(0.0883)	(0.0733)	(0.1109)
lnDROPOUT	-0.0105	0.065	0.0591	0.1464*	-0.097	-0.1385
	(0.0671)	(0.0763)	(0.0793)	(0.0752)	(0.0752)	(0.0925)
lnNEET	0.2218***	0.2854***	0.3188**	0.1977*	-0.1824	-0.16
	(0.0750)	(0.0758)	(0.1191)	(0.1141)	(0.1200)	(0.1661)
UNEMPL	-0.0240***	-0.0330***	-0.0304*	-0.012	-0.0209***	-0.0229***
	(0.0048)	(0.0044)	(0.0160)	(0.0160)	(0.0050)	(0.0059)
RATE	0.0995	0.09	0.1840**	0.2098***	-0.0222	-0.0296
	(0.0586)	(0.0625)	(0.0660)	(0.0634)	(0.0527)	(0.0511)
lnGDPH	-0.4521	-0.4356	-0.3793	0.0465	-0.4848	-0.512
	(0.2732)	(0.2800)	(0.3391)	(0.3141)	(0.3344)	(0.4768)
lnWEALTH	0.5249***	0.0349	0.6425***	-0.0076	0.1973	0.114
	(0.1452)	(0.2604)	(0.1780)	(0.2408)	(0.1354)	(0.2773)
AGE	0.0711*	0.1828***	0.0955	0.0978	0.1855**	0.2990***
	(0.0397)	(0.0493)	(0.0564)	(0.0674)	(0.0690)	(0.0753)
SIZE	-0.3181*	-0.0697	-0.3134	-0.0464	-0.3986*	-0.3872*
	(0.1769)	(0.1816)	(0.1939)	(0.1958)	(0.2005)	(0.2070)
Constant	1.3048		-2.2414		5.2216	
	(4.6889)		(5.5545)		(4.4586)	
NT	220	180	132	108	88	72
N	20	20	12	12	8	8
R^2	0.877	0.746	0.862	0.72	0.927	0.835

Note: p<0.1*, p<0.05**, p<0.01***.

Source: Authors' elaboration based on Bank of Italy, Eurostat and Istat data.

The determinants that drive families to buy real estate in Table 4 may differ from those previously described because mortgages shape a large part of household wealth (Finocchiaro et al. 2011).

The effects of human capital on the choices to obtain a mortgage for the purchase of a house (Table 4) are similar to the previous case (Table 3). The effect of education is negative in the South in the IV regression. For the Center-North, the 2SLS results confirm the findings of Magri (2002, on Italy) on the positive effect of education up to the secondary level for mortgages.

The greatest boost to indebtedness in the North is derived from the volume of family net worth, which represents a sort of guarantee that facilitates indebtedness. In this sense, we must consider that the average wealth has been affected by both the 2007 crisis and the credit rationing of the same period (Amuedo-Dorantes and Borra 2018).

The direct relationship of net wealth (see King and Leape 1998) is confirmed in the North (FE model). A clear limit in the South is represented by the average family size. As is observable for Italy, unemployed people generally have less access to credit (see Cox et al. 2006), and in the South this problem is evident, with an average unemployment rate in 2014 of 20.7%, and 9.4% in the Center-North in the same period (Istat data).

On mortgages, Vacca et al. (2013) find a convergence between the Italian regions: Territorial differences are mainly due to different income levels and real estate prices, while fewer differences in banking offers are present.

We must consider that the strong economic disparity in Italy influences the different spread of mortgages because real estate assets (and therefore mortgages) are distributed more unequally than debts (Cox et al. 2006), a relative stability of house prices exists (Caliman 2009), thus confirming greater polarization toward the wealthy North of the country.

Table 5. Consumer credit: Panel data analysis for Italy and the two macro areas

	Italy		Center-North		South	
	FE	2SLS	FE	2SLS	FE	2SLS
lnEDUSEC	0.5805	0.6414	1.0857**	1.2744***	-0.3764	-0.2479
	(0.3609)	(0.4845)	(0.3596)	(0.4299)	(0.5326)	(0.4285)
lnEDUTER	0.6120***	0.4645**	0.6078**	0.5153***	0.4641**	0.4138
	(0.1851)	(0.2043)	(0.2547)	(0.1843)	(0.1956)	(0.3230)
lnLLL	-0.2065***	-0.1900***	-0.1643**	-0.1857***	-0.3065*	-0.1990***
	(0.0697)	(0.0519)	(0.0590)	(0.0526)	(0.1340)	(0.0753)
lnDROPOUT	-0.0568	0.0092	-0.0671	0.0243	-0.0633	-0.0724
	(0.0556)	(0.0390)	(0.0500)	(0.0516)	(0.2039)	(0.0831)
lnNEET	0.0213	-0.0536	0.1591	0.0699	-0.3718	-0.3302***
	(0.0772)	(0.0740)	(0.1109)	(0.0938)	(0.2553)	(0.1069)
UNEMPL	-0.0337***	-0.0283***	-0.0429**	-0.0306***	-0.0226**	-0.0216***
	(0.0063)	(0.0064)	(0.0164)	(0.0111)	(0.0066)	(0.0047)
RATE	0.0464	0.0051	0.0739	0.0544	0.0082	-0.0626
	(0.0745)	(0.0611)	(0.1016)	(0.0614)	(0.0701)	(0.0626)
lnGDPH	-0.9877***	-1.1370***	-1.0162**	-1.0199***	-0.9968*	-1.4742***
	(0.3400)	(0.3045)	(0.3272)	(0.2263)	(0.4227)	(0.3453)
lnWEALTH	0.8582***	0.2714	0.8792***	0.0606	0.8533***	0.2606
	(0.1618)	(0.3212)	(0.2069)	(0.2722)	(0.2345)	(0.3256)
AGE	-0.0452	-0.0236	-0.1292	-0.1240**	0.0052	-0.0322
	(0.0385)	(0.0368)	(0.0835)	(0.0568)	(0.0601)	(0.0513)
SIZE	0.002	0.2803*	0.0235	0.4741***	-0.2956*	-0.1938
	(0.1792)	(0.1693)	(0.2205)	(0.1652)	(0.1346)	(0.1848)
Constant	7.1407		8.4069		11.4618	
	(5.4166)		(6.0573)		(7.8955)	
NT	220	180	132	108	88	72
N	20	20	12	12	8	8
R^2	0.839	0.49	0.813	0.514	0.909	0.688

Note: p<0.1*, p<0.05**, p<0.01***.

Source: Authors' elaboration based on Bank of Italy, Eurostat and Istat data.

For King and Leape (1998), education should be relevant for mortgages but not for consumer credit. In Table 5, we observe a lower significance of EDUSEC in the Center-North but also a positive contribution of EDUTER (IV regression), while no effects are found in the South when the endogeneity relation is considered.

The unemployed have less access to this form of credit, and, as incomes grow, people tend to make less use of it. Net worth has a direct relationship and probably has a greater influence on "major" purchase decisions (e.g., cars). The negative sign of income can be compared with the results of Magri and Pico (2012), who find that consumer credit grew in the post-crisis period for very low-income households to limit the negative effects on income due to economic turbulence. The use of consumer credit is instead reduced for higher incomes and pensioners. The influence of wealth is similar to Table 4. However, a greater correlation should be present between secured debts (such as mortgages) and family wealth as linked to higher real estate prices (typical of the highest quintiles) and related to income inequality (Cox et al. 2006).

Furthermore, the choice to access consumer credit also depends on the psychological factors underlying consumer choices (Cosma and Pattarin 2011). This type of debt strongly depends on impulsivity, which is not influential in secured debt (Ottaviani and Vendone 2011).

An interesting result of our analysis is the generally negative sign of lifelong learning. This could be strongly influenced by increasingly precarious working conditions, which often preclude certainty in future income (Riach et al. 2016) for a growing share of the population. The detected influence can be viewed as a discouraging sign toward educational practice that is already scarce in the country (especially in the South, Eichhorst et al. 2015). Furthermore, we observe the increasing relevance of the NEET phenomenon in influencing social and economic decisions in a country affected by a prolonged post-crisis recession and of the school dropout rate, which particularly harms the development of human capital and the economy of the most fragile part of the country, i.e., the South.

6. Conclusions

Human capital and education are particularly important determinants of the debt demand side, whereas generally less importance is accorded to the supply side, concerning the factors that a bank considers in granting a loan (e.g., future income). In Italy, the direct relationship between education and average indebtedness of households is observed although with limited relationships to low levels of education, thus confirming the low economic importance of human capital in many regions (Odoardi and Muratore 2018) due to the low-tech economic specialization and low average level of education (OECD 2017). In the financial field, as education grows, financial awareness also grows, helping avoid mistakes related to debt choices (such as overindebtedness and loan conditions). The positive sign of education in our

analysis suggests less access to credit for people with a very low level of human capital and (often associated) low income, as found by Magri and Pico (2012) for the Bank of Italy. However, different effects exist between secondary and tertiary education in the comprehension of contracts (Mitrakos and Simigiannis 2009), and the instrumental variables regression suggests a prevalent effect of the secondary level and only in the Center-North area.

In general, the Italian case differs from those of other Western countries concerning human capital for diverse reasons. The first concerns the limited influence of (high) education on local development processes (Di Liberto 2008) and consequently on income. The second concerns the relatively low number of graduates in Italy (approximately 17% of the population), as seen in the Eurostat data, which is still far from the European average of approximately 30%. This leaves great room for improvement in the quality and size of Italian households' finances, which can benefit from the necessary development of human capital.

Relevant aspects are found in the comparison between the North and South and between two types of debt: consumer credit and mortgages for the purchase of household real estate.

First, education has less relevance in the South, where qualitative and quantitative gaps in this sense are present (Abramo et al. 2016). Furthermore, the different efficiencies of local financial systems must be considered, which restrict access to credit in the South through higher costs (Resti 1997).

Second, the level of consumer credit is homogeneous among all the regions, depending on the minor constraints. Consumer credit has therefore been confirmed as an important resource for the South to maintain adequate levels of consumption in a period of rising unemployment and economic turbulence. In particular, we refer to the findings of Magri (2002), which confirm consumer loans as an easier and more direct element of consumption; as a result, the influence of human capital is stronger and more important with mortgages, as measured by our coefficients.

A higher commitment to the development of advanced education can therefore have a double economic value. It creates opportunities for greater access to credit with the aim of supporting consumption, which in turn can support local aggregate demand, especially in conditions of economic slowdown. Furthermore, it improves the quality of credit by allowing households to choose the types of debt most suited to their characteristics. In addition, human capital can be seen as a sort of collateral related, for example, to mortgages, because of the educational returns. In our case, a public and private commitment to increasing human capital in all the regions should improve the condition of the North and reverse the situation in the South,

which probably has not yet reached a sufficient average value to trigger positive effects and spillovers.

Limits to this work can be found in the lack of comparison with a pre-crisis analysis, which is difficult due to the lack of availability of the time series data. In further investigations, individual behavior and rationality should be considered (Ranyard et al. 2006; Meier and Sprenger 2010). Other aspects must be included, such as the role of impulsivity presented by Ottaviani and Vandone (2011) or the personal attitudes, psychological factors, and other factors described by Cosma and Pattarin (2011). In addition, our findings can be considered a first approach on which to construct more detailed analysis by the use of microdata in future research.

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Bahar Bayraktar Sağlam[*] - Selin Sayek Böke[†]

WAGE INEQUALITY, UNEMPLOYMENT AND LINKAGES: DO THE MULTINATIONAL ENTERPRISES RIDE TO THE RESCUE?

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Abstract

This paper aims to discuss the wage and unemployment effects of backward, horizontal and forward linkages established between MNEs and domestic firms in imperfect labor markets. The search and matching model allows us to derive different wages for different types of linkages. The findings of the paper suggest that buyer-supplier linkages between domestic and foreign firms and reservation wages due to frictions in the labor market are responsible for the differential wage effects of foreign firms. The paper also highlights the crucial effect of linkages on job creation and unemployment rates in local economies.

JEL CLASSIFICATION: F16; F23; J31.

KEYWORDS: SEARCH AND MATCHING MODELS; MULTINATIONAL FIRMS; LINKAGES.

[*] Economics Department, Hacettepe University, Beytepe, Ankara, 06800, Turkey, +90312297865; E-mail: sbahar@hacettepe.edu.tr

[†] Economics Department, Bilkent University, Bilkent, Ankara, 06800, Turkey, +903122901643; E-mail: sayek@bilkent.edu.tr

1. Introduction

Following the entry decision of multinational enterprises (MNEs) into new markets, both intra- and interindustry linkages between local and MNEs are established. These linkages between MNEs and domestic firms act as a source of externalities, causing linkages to play a crucial role in the examination of the effects of MNEs on local economies. MNEs contribute to the development of local firms through these linkages (Rodriguez-Clare, 1996 and Markusen and Venables, 1997). MNEs could establish horizontal or vertical linkages with local firms in recipient countries. The different types of linkages established upon MNE entry may have differential impacts on recipient economies. In this context, an impressive body of empirical evidence has developed around the effects of foreign presence either through horizontal or vertical linkages on the productivity of domestic firms. First, domestic firms can benefit from the presence of foreign firms in the same industry, leading to intraindustry or horizontal spillovers through the movement of workers within industries, demonstration effects, improved product design, reverse engineering and competition effects. Second, domestic firms can benefit from the presence of foreign firms in downstream or upstream industries through the existence of buyer-supplier linkages. These vertical linkages, forward (toward downstream industries) or backward (toward upstream industries), can generate spillovers through the superior proprietary asset, knowledge and technology embodied in the inputs multinationals provide to the local firms in the former channel or in the input needs of multinationals from the local firms in the latter channel.

Despite the significantly large number of studies on differential productivity spillovers from different types of linkages, the possible wage spillovers and labor market implications of the different types of linkages have not been theoretically studied in such detail. This paper attempts to examine the effect of horizontal, backward and forward linkages between foreign and domestic firms on the local labor markets by constructing a theoretical framework to study the wage and employment effects of different types of linkages. Using search and matching models, it aims to provide insights into the effects of linkages on absolute and relative wages and unemployment rates in the recipient economy. Because there have only been a scant number of theoretical attempts at studying the labor market effects of vertical or horizontal linkages on the host economy, this paper fills the gap in the

literature by discussing the effects of horizontal and vertical linkages on local wages and unemployment.

The theoretical model allows the identification of several proposals regarding the differential wage and employment effects of horizontal versus vertical linkages. First, the model suggests that increased foreign presence in the form of horizontal and vertical linkages puts upward pressure on high-skilled wages. In this context, backward linkages generate the highest level of high-skilled wages in both domestic and foreign firms, but wages paid to high-skilled workers are lowest if horizontal or forward linkages exist between domestic and foreign firms. Low-skilled workers are found to earn the highest wage if forward linkages exist between foreign and local firms, and they end up with the lowest wage if there are backward linkages. Second, the firm premium, defined as the gap between foreign and domestic wages, is highest if backward linkages exist between foreign and local firms and lowest with forward linkages. Third, the skill premium, the gap between the high-skilled and low-skilled wages in domestic firms, is highest if backward linkages exist between foreign and local firms and lowest with forward linkages. Furthermore, the results also reveal that the unemployment rate of low-skilled workers is highest if there are backward linkages between foreign and domestic firms and lowest if there are forward linkages. The unemployment rates of skilled workers are highest if MNEs and domestic firms act in the same sector (horizontal linkages) and lowest if there are forward linkages.

To summarize, when providing incentives to facilitate the entry of foreign firms into the local markets, one needs to devote a crucial role to the linkages between domestic and foreign firms. Backward linkages may hurt low-skilled workers and increase wage inequality between high-skilled and low-skilled workers. Furthermore, if domestic firms are suppliers of multinationals, there will be less job creation in the domestic labor market compared to the forward and horizontal linkages. Even though there is a reduction in the unemployment rate of high-skilled workers upon the entry of foreign firms, the greatest unemployment rates of both high-skilled and low-skilled workers are recorded under backward linkages. That is, building up backward linkages with foreign firms works for the benefit of high-skilled workers, but setting up forward linkages supports the well-being of low-skilled workers. Therefore, policy makers should consider the role of linkages on high-skilled and low-skilled workers prior to providing incentives to attract multinationals. For instance, if governments aim to end up with the lowest rate of unemployment for both high-skilled and low-skilled workers and impede wage inequality upon the

entry of multinationals, they should support the development of forward linkages.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 displays the numerical example, and the last section provides the conclusion.

2. Literature Survey

Focusing on productivity spillovers through these linkages, the literature has mostly found that horizontal spillovers are elusive within developing economies, whereas they seem to prevail positively within developed countries (for example, Haddad and Harrison, 1993; Haskel et al., 2007; and Keller and Yeaple, 2003, among many others). Such elusive gains from horizontal linkages have spurred interest in studying vertical linkages, where studies have mostly found positive backward and negative forward spillovers from foreign to domestic firms' productivities (see Javorcik, 2004; Djankov and Hoekman, 2000; and Schoors and Van der Tol, 2001, among others). Given the differential result across countries with different economic development levels, recent studies have started to focus on identifying the necessary conditions that would allow linkages to create positive spillover effects (for example, Castellani and Zanfei (2001) and Mervelede and Schoors (2005) focus on the role of the technology level and export status of local firms).

Table 1. Literature on Wage Inequality and Linkages

Author	Data and Methodology	Types of Linkages	Findings
Aitken et al. (1996)	Firm-level data for Mexico and Venezuela	Horizontal	*Positive impact on foreign wages. *Negative impact on domestic wages.
Lipsey and Sjöholm (2004)	Cross-sectional plant-level data	Horizontal	*Positive impact on local real wages.
Driffield et al. (2003)	Plant-level data for the UK	Forward	*Less clear impact on wage inequality.
Pamukçu and Taymaz (2009)	Firm-level data for Turkey	Horizontal	*Positive for no production workers. *No effect for production workers.
Hoi and Pomfret (2010)	Firm-level data for Vietnam	Horizontal, Vertical	*Positive wage spillovers, and the magnitude of horizontal wage spillovers is larger than that of the vertical wage spillovers.
Driffield et al. (2010)	Plant-level data for the UK	Backward	*Backwardly linked FDI acts to reduce wage inequality at a national level, while there is weak evidence of an increase locally.
Hale and Long (2011)	Firm-level data for China	Horizontal	*Positive impact on skilled wages.
Muñoz-Bullon and Sanchez-Bueno (2013)	Firm-level data for Spain	Horizontal	*Only high-skilled workers benefit from horizontal spillovers.
Pittiglio et al. (2015)	Firm-level data for Italy	Horizontal, Vertical	*Positive effects on wages paid by domestically owned firms (horizontal linkages) *Negative effetcts on domestic wages (vertical linkages)

As discussed thus far, many studies have investigated the contribution of horizontal or vertical linkages to the productivity of domestic firms. However, a few have examined the labor market implications of the different types of linkages (see Table 1 for a literature survey). Of those studies presented in Table 1, most focused on the effects of horizontal spillovers on local wages while ignoring vertical spillovers altogether. Only Hoi and Pomfret (2010) and Pittiglio et al. (2015) have taken into account the possible horizontal and vertical linkages on wage inequalities. While Aitken et al. (1996), Lipsey and Sjöholm (2004), Pamukçu and Taymaz (2009), Hoi and Pomfret (2010), Hale and Long (2011), Munoz-Bullon and Sanchez-Buenos (2013) extensively supported the positive effects of horizontal linkages on wages, Driffield et al. (2003) and Pittiglio et al. (2015) found ambiguous or negative wage effects for vertical linkages. Thus, the empirical literature suffers from inconclusive findings for different countries.

2. The Model

2.1 Main Assumptions

All agents are risk-neutral and infinitely lived and discount the future at the common rate r. The economy is populated by a continuum of heterogeneous workers with measures normalized to one. The fraction of low-skilled workers in the population is denoted by μ, where $\mu \in (0{:}1)$ is exogenously given in the model. There are two types of jobs, foreign and domestic. Either type of worker can fill a domestic job. In contrast, foreign jobs can only be filled by high-skilled workers. The job destruction rate is given as exogenous, δ. The amount of output produced in domestic and foreign jobs with different types of workers is given as follows:

$$y_F = k_F^{\alpha_F} s_h y_{Dm}^{\gamma_m} y_{Dl}^{\gamma_l} \quad (1)$$

$$y_{Dm} = k_{Dm}^{\alpha_m} s_m y_F^{\kappa_F} \quad (2)$$

$$y_{Dl} = k_{Dl}^{\alpha_l} s_l y_F^{\phi_F} \quad (3)$$

Where s_h is the productivity of the high-skilled workers in the foreign firm, s_m is the productivity of the high-skilled workers in the local firm, s_l is the productivity of the low-skilled workers in the local firm. The productivity

of these jobs depends on the type of worker and the type of capital. Assume that high-skilled workers are more productive in foreign jobs yet less productive in domestic jobs, that is, $s_h > s_m$. In addition, the productivity of low-skilled workers is less than the productivity of high-skilled workers in domestic firms.

A backward linkage exists if foreign firms are supplied by domestic firms, that is, $\phi_F = \kappa_F = 0$. A forward linkage is a relationship whereby domestic firms buy intermediate or final products produced by foreign firms, that is, $\gamma_m = \gamma_l = 0$. Horizontal linkages occur if both foreign and domestic firms are operating in the same sector, that is, $\phi_F = \kappa_F = \gamma_m = \gamma_l = 0$.

The net revenue of foreign and domestic firms generated by high-skilled and low-skilled workers is:

$$R_F = \begin{cases} p_F y_F - p_{kF} k_F \ \ if\ \gamma_m = \gamma_l = 0\ and\ \phi_F \neq 0, \kappa_F \neq 0 \\ p_F y_F - p_{kF} k_F - p_{Dm} y_{Dm} - p_{Dl} y_{Dl} \ \ if\ \phi_F = \kappa_F = 0\ and\ \gamma_m \neq 0, \gamma_l \neq 0 \\ p_F y_F - p_{kF} k_F \ \ if\ \gamma_m = \gamma_l = \ \phi_F = \kappa_F = 0 \end{cases} \quad (4)$$

$$R_{Dm} = \begin{cases} p_{Dm} y_{Dm} - p_{kDm} k_{kDm} - p_F y_F \ if\ \gamma_m = \gamma_l = 0\ and\ \phi_F \neq 0, \kappa_F \neq 0 \\ p_{Dm} y_{Dm} - p_{kDm} k_{kDm} \ if\ \phi_F = \kappa_F = 0\ and\ \gamma_m \neq 0, \gamma_l \neq 0 \\ p_{Dm} y_{Dm} - p_{kDm} k_{kDm} \ if\ \gamma_m = \gamma_l = \ \phi_F = \kappa_F = 0 \end{cases} \quad (5)$$

$$R_{Dl} = \begin{cases} p_{Dl} y_{Dl} - p_{kDl} k_{kDl} - p_F y_F \ if\ \gamma_m = \gamma_l = 0\ and\ \phi_F \neq 0, \kappa_F \neq 0 \\ p_{Dm} y_{Dm} - p_{kDm} k_{kDm} \ if\ \phi_F = \kappa_F = 0\ and\ \gamma_m \neq 0, \gamma_l \neq 0 \\ p_{Dm} y_{Dm} - p_{kDm} k_{kDm} \ if\ \gamma_m = \gamma_l = \phi_F = \kappa_F = 0 \end{cases} \quad (6)$$

where p_F is the price of the output produced by the foreign firm. p_{Dm} is the price of the output produced by the high-skilled workers in the domestic firm, and p_{Dl} is the price of the output produced by the low-skilled workers in the domestic firm. In addition, the price of capital is different across firms, and the price of capital is different for high-skilled and low-skilled workers in the domestic firm. Once a firm hires a worker and observes his skill, it rents capital in a perfectly competitive market; the profit-maximizing amount of capital is given as follows (Davidson et al., 2008)[3]:

[3] However, in Davidson et al. (2008), the price of the capital is numeraire, while in this model we allow for the different price of capital for domestic and foreign firms.

$$k_F = \frac{p_F}{P_{kF}} \alpha_F y_F \tag{7}$$

$$k_{Dm} = \frac{p_{Dm}}{P_{kDm}} \alpha_m y_{Dm} \tag{8}$$

$$k_{Dl} = \frac{p_{Dl}}{P_{kDl}} \alpha_l y_{Dl} \tag{9}$$

According to Eq. (7), we can model increased foreign capital via an exogenous increase in any one of the following variables: p_F, p_{kF}, α_F and s_h.[4]

2.2 Matching

Job seekers and firms with vacant jobs are matched together in pairs through imperfect matching technology. The total flow of contracts between a job seeker and a firm is determined by a standard constant returns to scale matching function:

$$m(v_D + v_F, u) \tag{10}$$

where v_D and v_F represent the mass of domestic and foreign vacancies, respectively, u is the mass of unemployed workers, η denotes the fraction of vacancies posted by local firms, and $1 - \eta$ is the fraction of vacancies posted by foreign firms. The labor market tightness is denoted by θ, where $\theta = \frac{v_D + v_F}{u}$. Accordingly, the rate at which firms meet a job seeker is equal to $\frac{m(\theta)}{\theta}$; similarly, workers may meet a job at rate $m(\theta)$. The properties of the matching function imply that the matching rate of workers (firms) is increasing (decreasing) in θ.

The job destruction rate is denoted by δ.

2.3 Firms

The value of employing a high-skilled worker for a domestic firm is J_{Dm} and for a foreign firm J_F. The value of employing a low-skilled worker for a domestic firm is J_{Dl}:

[4] Throughout the paper, we model an increase in foreign presence by an increase in productivity, s_h, or reduction in the cost of foreign capital, p_{kF}.

$$rJ_F = R_F - w_F - \delta J_F \quad (11)$$

$$rJ_{Dm} = R_{Dm} - w_{Dm} - \delta J_{Dm} \quad (12)$$

$$rJ_{Dl} = R_{Dl} - w_{Dl} - \delta J_{Dl} \quad (13)$$

where w_F and w_{Dm} denote the high-skilled workers' wages in the foreign and domestic firms, respectively, while w_{Dl} is the low-skilled workers' wages in the domestic firm.

The asset values of high-skilled workers in domestic and foreign firms are W_F and W_{Dm}, respectively, and W_{Dl} is the asset value of the low-skilled worker in the domestic firm:

$$rW_F = w_F - \delta(W_F - U_h) \quad (14)$$

$$rW_{Dm} = w_{Dm} - \delta(W_{Dm} - U_h) \quad (15)$$

$$rW_{Dl} = w_{Dl} - \delta(W_{Dl} - U_l) \quad (16)$$

Given the assumption that high-skilled workers accept both types of jobs, domestic and foreign, the asset value of unemployed high-skilled workers is denoted by U_h, and because the low-skilled workers can only match with the domestic firm, the asset value of unemployed low-skilled workers is represented by U_l:

$$rU_h = m(\theta)[\eta(W_{Dm} - U_h) + (1-\eta)(W_F - U_h)] \quad (17)$$

$$rU_l = m(\theta)\eta(W_{Dl} - U_l) \quad (18)$$

σ is the share of low-skilled workers in the unemployment pool. Let V_D and V_F be the values of a job when looking for a worker for domestic and foreign firms, respectively, that is, the value of a vacancy. These values satisfy the following equations:

$$rV_D = -c_D + \frac{m(\theta)}{\theta}[\sigma(J_{Dl} - V_D) + (1-\sigma)(J_{Dm} - V_D)] \quad (19)$$

$$rV_F = -c_F + \frac{m(\theta)}{\theta}[(1-\sigma)(J_F - V_F)] \quad (20)$$

A firm that posts a vacancy must pay a recruitment cost of c_D and c_F for domestic and foreign firms, respectively. Given free entry, all profit opportunities from posting vacancies are exploited; hence, in equilibrium, $V_D = V_F = 0$. The steady-state equilibrium conditions require that flows into and out of the employment state must be equal, and this condition is given by:

$$\delta(\mu - \sigma u) = \eta m(\theta) \tag{21}$$

$$\delta(1 - \mu - (1 - \sigma)u) = m(\theta)(1 - \sigma)u \tag{22}$$

2.4 Wages

The generalized Nash bargaining solution is widely used in matching models of the labor market. In this context, wages are given by[5]

$$w_F = \beta R_F + (1 - \beta) r U_h \tag{23}$$

$$w_{Dm} = \beta R_{Dm} + (1 - \beta) r U_h \tag{24}$$

$$w_F = \beta R_{Dl} + (1 - \beta) r U_l \tag{25}$$

where β is the bargaining power of the workers. Using Eq. (14) through (18), we can derive the asset value of unemployed workers discounted, rU_l and U_h, as follows:

$$rU_l = \frac{m(\theta)\eta\beta R_{Dl}}{r + \delta + \beta m(\theta)\eta} \tag{26}$$

$$rU_h = \frac{m(\theta)\beta[\eta R_{Dm} + (1 - \eta)R_F]}{r + \delta + \beta m(\theta)} \tag{27}$$

[5] The standard match requirement condition of search models requires that the total surplus is always positive, where total surplus (S) equals S=W−U+J−V, i.e., W−U+J−V≥0. The solution detailed in the following discussion exists under this condition. The proof is available from the authors upon request.

Using Eqs. (4), (5) (6), (26) and (27), we find the wages paid by foreign and domestic firms, respectively, as follows:

$$w_F = \beta R_F + (1-\beta)\frac{m(\theta)\beta[\eta R_{Dm} + (1-\eta)R_F]}{r+\delta+\beta m(\theta)} \tag{28}$$

$$w_{Dm} = \beta R_{Dm} + (1-\beta)\frac{m(\theta)\beta[\eta R_{Dm} + (1-\eta)R_F]}{r+\delta+\beta m(\theta)} \tag{29}$$

$$w_{Dl} = \beta R_{Dl} + (1-\beta)\frac{m(\theta)\eta\beta R_{Dl}}{r+\delta+\beta m(\theta)\eta} \tag{30}$$

Eqs. (28) through (30) show that wages paid are a weighted average of the value the worker generates for the firm (the first term) and the value of the reservation wage of the worker (the second term). The weights are determined by the bargaining power of the worker, β. This is a standard feature of the search models, showing that the wage determination does not solely depend on the marginal revenue product of the worker but also on the labor market imperfections, which are captured by the matching function, $m(\theta)$, and the share of local vacancies in total job vacancies, η. The latter term of all wage equations captures this phenomenon, where the reservation wage is an average wage the worker could obtain from foreign and domestic firms. Stated differently, reservation wages are weighted averages of net revenue of domestic and foreign firms, where weights are determined by the labor market conditions represented by the share of domestic (η) and foreign vacancies ($1-\eta$) in total job vacancies and the labor market tightness, θ. Therefore, it is crucial to determine the mass of foreign and domestic vacancies together with the labor market tightness in the equilibrium before examining the wage effects of foreign firm entry with different linkages. Once the extent of local and/or foreign firm vacancy creation is determined, the effects on absolute and relative wages as well as the unemployment rate can be discussed conveniently. The equilibrium in this model is determined by two job creation conditions, which are represented by equations (19) and (20), plus the two steady-state conditions equalizing the flows into and out of unemployment for domestic and foreign firms via equations (21) and (22). Given exogenous variables that capture the productivity of workers (s_h, s_m and s_l), bargaining

power (β), the job destruction rate (δ), job creation costs (c_D and c_F), the share of the unskilled population (μ), and the interest rate (r), we will solve for the mass of foreign and local vacancies, the unemployment rate (u) and the share of unskilled workers in the unemployment pool (σ). However, it is not possible to derive an explicit solution for the mass of domestic v_D and foreign vacancies v_F, which determines $m(\theta)$ and η. Thus, the next section provides a numerical example.

3. Numerical Example

In this section, we provide a numerical example to illustrate the properties of the model. Our main objective is to study the effects of an increase in foreign firm presence on a range of wages. Because foreign capital, k_F, is endogenously determined in the model, the numerical exercise requires a change in an exogenous factor that will lead to higher foreign capital in the model. According to Eq. (7), exogenous changes in the productivity measure can be a factor that leads to increased foreign capital, or a reduction in the cost of foreign capital may be another factor that will lead to higher foreign firm presence. As such, we undertake the exercise of changing the productivity and cost parameter separately and observe the evolution of absolute and relative wages at different linkages. The parameters are calibrated to match existing studies in the literature. Our goal is to discuss the effects of a change in the extent of foreign firm activity and not to match the results one-to-one with any specific economy.

The baseline parameters are set as follows: r= 0.05, $\beta = 0.5$, $\delta = 0.2$, $c_D = 2$, $c_F = 2$, $\mu = 0.8$, $s_h = 10$, $s_m = 9$, $s_l = 8$, $\alpha_m = 0.04$, $\alpha_l = 0.03$, $\alpha_F = 0.5$, $\alpha_m = 0.04$, $\gamma_m = 0.03$, $\gamma_l = 0.05$, $\phi_F = 0.04$, $\kappa_F = 0.05$, $p_D = 1$, $p_F = 1$, $p_{kDm} = 1$, $p_{kDl} = 1$, and $p_{kF} = 1$. The example uses the matching function $m(\theta) = 2\sqrt{\theta}$

All these parameter values are reasonable and in line with other studies, including Albrecht and Vroman (2002), Gautier (2002) and Dolado et al. (2009)[6]. Below, we detail some of these parameters that are specifically important for our discussions. The productivity gap between foreign and local firms, s_h and s_m, is assumed to be approximately 50%. This assumption is based on rich literature that suggests that the productivity gap between foreign

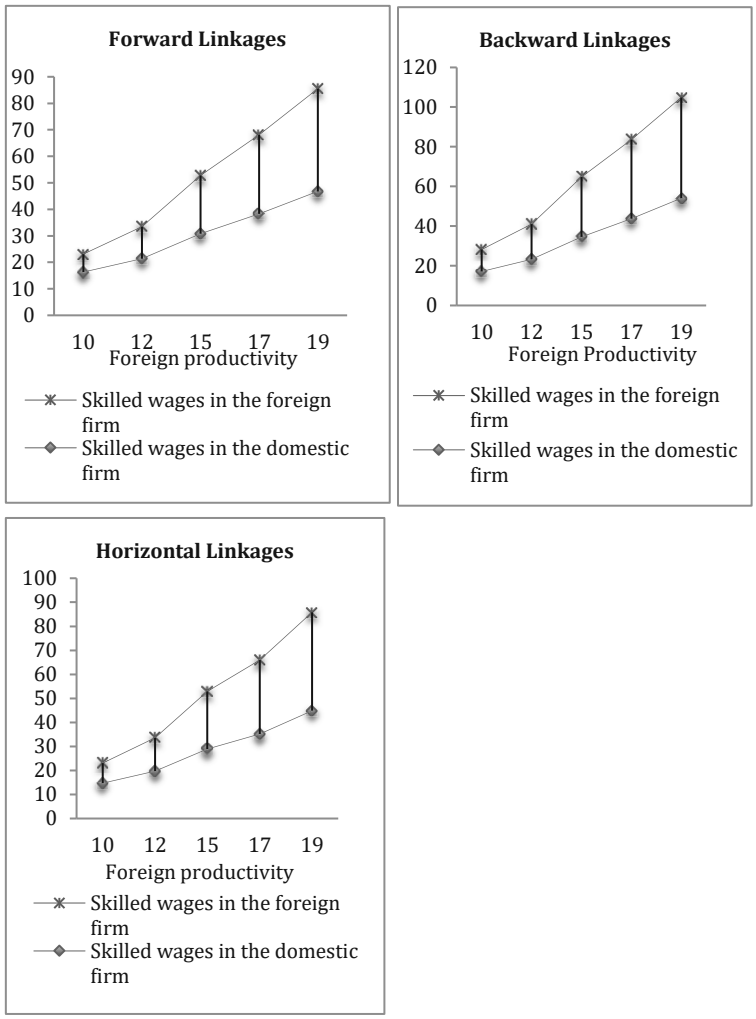
[6] The analytical solution, which is available in the Appendix, helps us to make some parameter restrictions, such as 1-$\alpha_F - \gamma_m - \gamma_l < 0$, $1 - \alpha_m - \kappa_F < 0$, and $1 - \alpha_l - \phi_F < 0$.

and local firms ranges from 10% to 100% (see Conyon et al., 2002; Kimura and Kiyota, 2007, among others). The interest rate is 5%, and the job destruction rate is 0.2. For simplicity, the prices are all normalized to 1, except for the price of foreign capital. The exercise allows for the identification of how absolute and relative wages change as foreign presence increases (in this case, as the foreign productivity parameter increases or the cost of foreign capital decreases). The numerical simulation results, where the effects of a change in foreign capital on market tightness and vacancy distribution are taken into account, favor the discussion of the labor market implications of foreign firms with different linkages.

3.1. Absolute Wages

Using Eqs. (28) through (30), it is possible to establish a rich set of wages capturing linkages between foreign and domestic firms. The explicit representation of wages paid to high-skilled and low-skilled workers corresponding to different linkages is available in the Appendix. Equations (A1) through (A9) highlight that domestic and foreign firms' relative positions in the supply chain play an important role in terms of determining the net revenues of the firms and the reservation wage of the worker. Alternately, the impact of foreign firm productivity or reduction in the cost of foreign capital affects both net revenues of firms and reservation wages of high-skilled workers in the foreign firms for all linkages. For the backward and horizontal linkages, the impact of foreign presence on the wages of high-skilled workers in the domestic firm is captured by a change in the reservation wages. However, for forward linkages, the entry of foreign firms may affect the wages of high-skilled workers in domestic firms by changing both the net revenue of the domestic firms and reservation wages. That is, both the net revenues of firms and reservation wages are responsible for wage formation in all linkages but to a different extent. The important role played by the imperfections of the labor market is also evident in all reservation wages.

Figure 1. Comparison of wages paid to skilled workers across foreign and domestic firms



Source: Author's own elaboration

Figure 1 presents a comparison of wages paid to high-skilled workers across foreign and domestic firms. The vertical axis presents the wages paid

by foreign and domestic firms to high-skilled workers, and the horizontal axis captures the productivity of foreign firms. The numerical solution represented in Figure 1 reveals that skilled workers are better paid in foreign firms than in domestic firms for all types of linkages. This finding is consistent with empirical studies provided by Driffield and Girma (2003), Conyon et al. (2002), Martins (2004), and Aitken et al. (1996). They also document that foreign firms pay higher wages because they are larger, more skill intensive and associated with higher technology. Further observation from Figure 1 is that the wage gap between foreign and domestic firms for high-skilled workers is sensitive to foreign firm productivity. Furthermore, productivity improvements by foreign firms widen the technology gap between domestic and foreign firms and expand the wage gap between foreign and domestic firms for high-skilled workers.

Throughout the paper, the prevalence of multinationals is captured by foreign firm productivity or a reduction in the cost of foreign capital. Figure 2 and Figure 3 show the impact of foreign presence on wages paid to high-skilled workers in foreign and domestic firms for all linkages. The first observation from those two figures is that wages paid to high-skilled workers by domestic and foreign firms increase as a result of increased foreign firm presence, either by productivity gains or cost reduction. However, the extent of the rise in wages is stronger in the case of cost reduction in foreign capital. Thus, one can conclude that the entry of foreign capital via cost advantage provides higher gains to high-skilled workers in foreign and domestic firms.

Figure 2 and Figure 3 display the evolution of wages paid to high-skilled workers by foreign and domestic firms, respectively. Backward linkages pay higher wages to high-skilled workers than forward and horizontal linkages. Under imperfect labor markets, domestic firms that are suppliers of foreign firms have to pay more for high-skilled workers, not only to meet the production requirements set by multinationals but also to match with high-skilled workers in the labor market. Within the search and matching framework, the increased net revenue and the higher skill requirements of foreign firms generate upward pressure on reservation wages, which in turn pushes up the wages paid to high-skilled workers in both domestic and foreign firms. Therefore, backward linkages generate higher wages for high-skilled workers in imperfect labor markets by pushing up reservation wages. In perfectly competitive labor markets, wage spillovers are directly linked to productivity spillovers. However, the search and matching model has verified

that some part of the wage spillovers could be attributed to reservation wages in addition to the change in the net revenue of the firms.

Alternately, higher wages associated with backward linkages are also partly supported by empirical evidence spillovers, which verifies that backward spillovers are relatively more likely to occur than horizontal spillovers (Javorcik, 2004; Giroud, 2007; Blalock and Gertler, 2008 and Havranek and Irsova, 2011). In particular, productivity spillovers from backward linkages may take place through direct knowledge transfer from foreign customers to domestic suppliers. This could happen by two channels. First, foreign firms may force domestic suppliers to upgrade their production process or technology to use existing resources more efficiently, and foreign firms may set higher requirements for product quality to increase the quality of the intermediate inputs they purchase from domestic suppliers (Lal, 1980; Pittiglio et al., 2015; Javorcik, 2004). Second, the presence of foreign firms increases demand for intermediate products, which allows local suppliers to exploit economies of scale (Rivera-Batiz and Rivera-Batiz, 90).

Furthermore, according to equations (A1) through (A9), the gap between wages paid to high-skilled workers at the backward and forward levels could be attributed to the differences in the net revenue of foreign and domestic firms, thereby leading to differences in reservation wages. At the forward level, domestic firms may become more productive as a result of gaining access to new, improved, less costly intermediate inputs produced by foreign firms (Javorcik, 2004; Marcin, 2008). Under the umbrella of a search and matching framework, the direct impact of foreign productivity on the net revenue of domestic firms and its indirect influence on reservation wages are responsible for the formation of wages paid to high-skilled workers at the forward linkages. The numerical simulation has revealed that the contribution of the net revenue of foreign firms to reservation wages at the backward level dominates the contribution of the net revenue of domestic firms to reservation wages at the forward level. Wage spillovers at the backward level, which take place through increased reservation wages, suppress wage spillovers at the forward level, which take place through increased net revenue of the domestic firm and reservation wages. At backward linkages, foreign firms expand their own production technology by forcing domestic suppliers to become more productive and efficient, and they push up the wages paid to high-skilled workers by increasing the reservation wages for them. However, in the forward linkages, there is no change in the net revenue of foreign firms, but there is an improvement in the net revenue of domestic firms because they

have access to intermediate inputs produced by foreign firms. An increase in the net revenue of foreign firms associated with backward linkages forces both foreign and domestic firms to pay higher wages for high-skilled workers. In fact, at the forward level, gains in the net revenue of domestic firms are shadowed by the gains in the net revenue of foreign firms at the backward level, so the contribution of domestic firms becomes limited when compared with the foreign firms' contribution to reservation wages.

Alternately, foreign firms pay approximately the same wages to high-skilled workers if forward or horizontal linkages are established between domestic and foreign firms. This could be partly explained by the fact that the net revenue of a foreign firm is the same for the forward and horizontal linkages. The net revenue of a foreign firm at the backward linkages dominates at both the forward and horizontal linkages. The contribution of foreign presence to the formation of wages paid to high-skilled workers is very limited for the case of horizontal linkages. This is quite similar to the empirical findings, which have assigned a greater role for backward externalities than horizontal externalities. The empirical support for the lack of horizontal externalities could be partly explained by the fact that multinationals do not prefer to share new knowledge and technology with domestic firms because they act in the same sector. Thus, buyer-supplier linkages between domestic and foreign firms play an essential role in the determination of wage spillovers. Similarly, Figures 2 and 3 lend supporting evidence to the empirical findings, which argue that, if foreign presence was to generate wage spillovers, they are more likely to be backward in nature rather than horizontal.

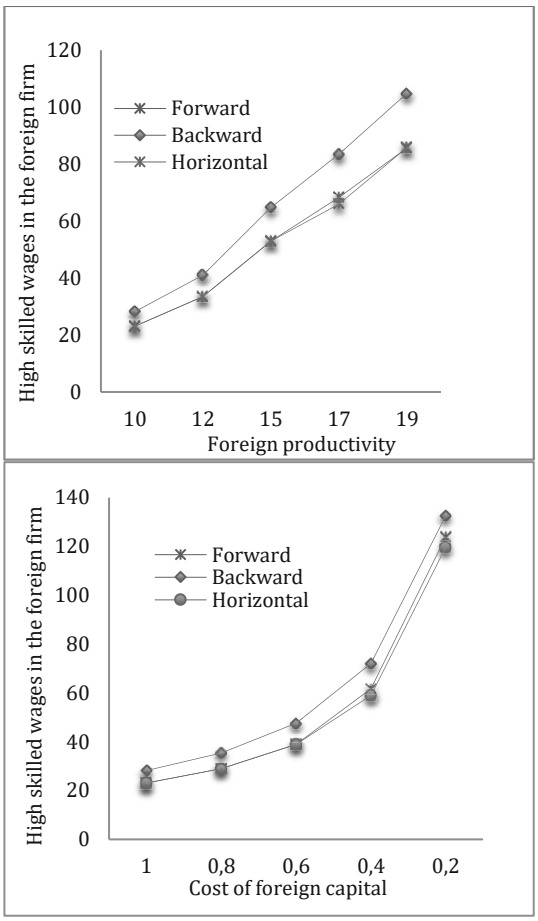
Figure 4 presents the evolution of wages paid to low-skilled workers associated with different linkages. Wages paid to low-skilled workers are highest at the forward linkages and lowest for the backward linkages. Because it is possible to capture the contribution of foreign firms to domestic firms as they provide less costly and technologically advanced input at the forward level, the net revenue of domestic firms employing low-skilled workers will be higher than that of the backward and horizontal linkages. The direct contribution of foreign presence to the wages of low-skilled workers is only possible if foreign firms prefer to provide technologically advanced new inputs to domestic firms. For the backward and horizontal linkages, the impact of foreign presence on low-skilled wages is captured only by changes in labor market tightness and the share of local vacancies in the total job vacancies. There is no direct influence of foreign productivity on low-skilled wages in the backward and horizontal linkages. Wages paid to low-skilled workers in

domestic firms are lowest if backward linkages are established between domestic and foreign firms. At the backward level, this may happen if the contribution of low-skilled domestic firms to foreign production is limited or if high-skilled domestic firms dominate the low-skilled domestic firms. Therefore, domestic vacancies may increase toward high-skilled workers, and low-skilled workers may hardly match domestic firms. In other words, low-skilled workers may become worse off due to the shift in vacancy formation toward high-skilled workers. Alternately, the contribution of foreign presence to wages paid to high-skilled workers is captured by the increased reservation wages for those workers, but for low-skilled workers, who can only match with low-skilled domestic jobs, they may not face any competition between domestic and foreign firms. At horizontal linkages, low-skilled workers may have slightly higher wages than backward linkages. Frictions in the labor market could capture the slight difference between wages paid to low-skilled workers in backward and horizontal linkages.

Figure 4 also displays the impact of increased foreign presence on wages paid to low-skilled workers in domestic firms. According to the wage equations (A1) through (A9) represented in the Appendix, the impact of increased foreign production or reduction in the cost of foreign capital has influenced both marginal revenue products of worker and reservation wages in the forward linkages. However, at the backward and horizontal linkages, the impact of foreign presence on low-skilled wages is influenced only by the change in labor market conditions upon the entry of foreign firms; thus, there is no direct contribution of foreign presence to wages paid to low-skilled workers. Increased foreign firm presence via gains in foreign firm productivity or reduction in the cost of foreign capital leads to a slight increase in the wages paid to the low-skilled workers in the domestic firm if there are forward linkages between domestic and foreign firms. However, if foreign firms are suppliers of intermediate inputs for domestic firms, the wages of low-skilled workers in the domestic firm record a slight decrease following the increase in foreign capital via productivity gains or a cost reduction. Similarly, an increase in foreign presence has a negligible negative impact on the wages of low-skilled workers in the domestic firm if there are horizontal linkages.

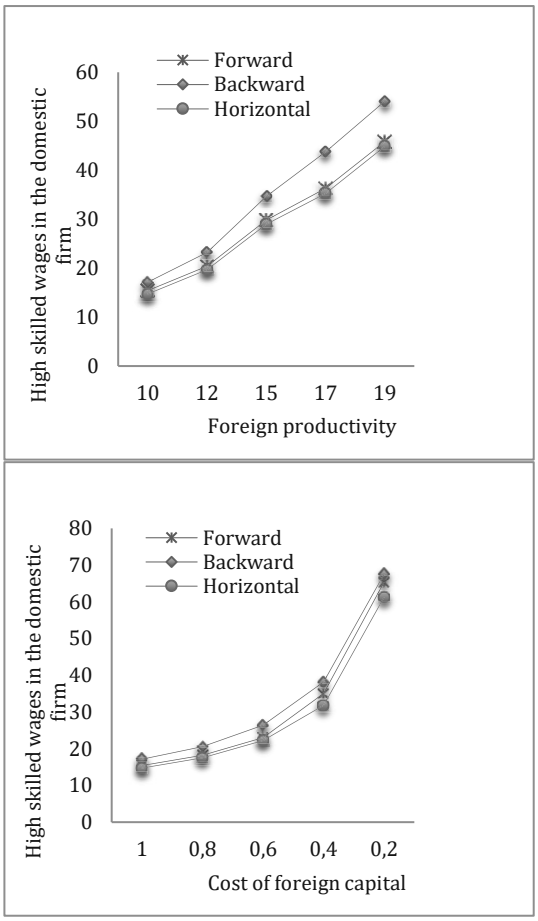
Thus, low-skilled workers are better off only if foreign firms offer cheap and advanced inputs to domestic firms. Otherwise, the contribution of foreign presence to low-skilled wage formation is limited only by domestic vacancy creation, which has influenced labor market tightness and the share of domestic vacancies in the total vacant jobs.

Figure 2. Skilled wages in the foreign firm (backward, forward and horizontal linkages)



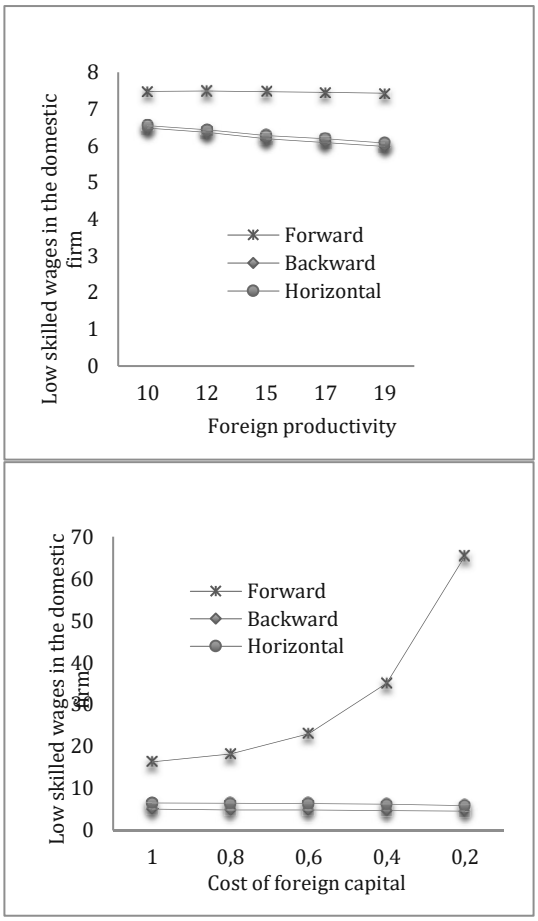
Source: Author's own elaboration

Figure 3. Skilled wages in the domestic firm (backward, forward and horizontal linkages)



Source: Author's own elaboration

Figure 4. Unskilled wages in the domestic firm (backward, forward and horizontal linkages)



Source: Author's own elaboration

3.2 Relative Wages

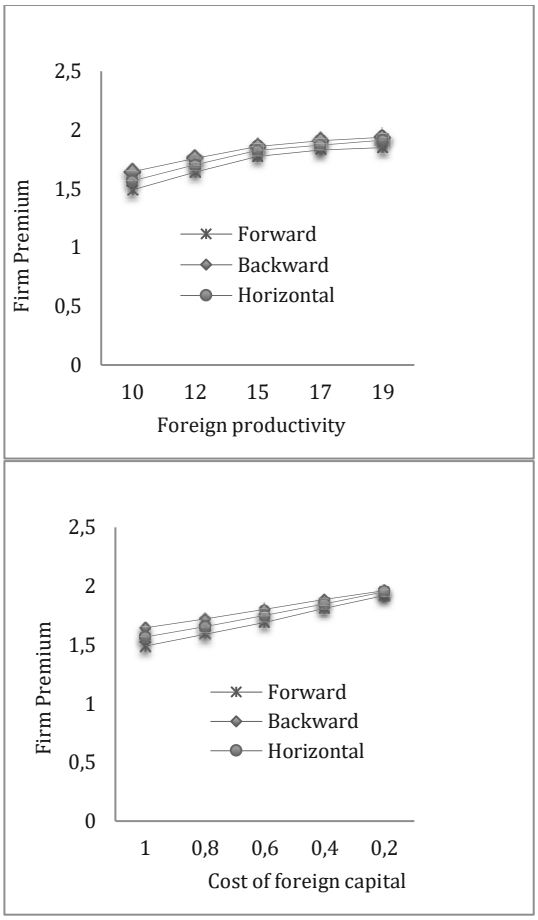
In addition to the absolute wages, it is also possible to discuss the foreign firm premium and the skill premium (or the relative wages) for the different linkages. Figure 5 and Figure 6 represent the evolution of foreign firm premiums and skill premiums upon the entry of foreign firms, respectively.

One finding that emerges from Figure 5 is that the foreign firm premium is more than one, indicating that foreign firms pay higher wages than domestic firms for skilled workers, which is also supported by Figure 1. Other evidence from numerical simulation suggests that entry of foreign capital via productivity growth or a reduction in the cost of foreign capital increases foreign firm premiums for all linkages. Further observation from Figure 5 shows that foreign firm premiums are greatest when there are backward linkages and lowest when there are forward linkages. In addition to the discussion on absolute wages, which reveals that backward linkages offer higher wages for high-skilled workers than forward and horizontal linkages, findings on foreign firm premiums also reveal that the wage gap between domestic and foreign firms at backward linkages appears to be greater than that of the forward and horizontal linkages. Within the search and matching model where productivities are exogenously given and wages are endogenously determined according to labor market imperfections, the wage gap between foreign and domestic workers depends extensively on labor market conditions. Under backward linkages, the net revenue of foreign firms is larger than the net revenue of domestic firms, which will contribute to higher reservation wages for high-skilled workers, which in turn generates higher wages for skilled workers. At the forward level, both low-skilled and high-skilled workers in domestic firms have benefited from foreign presence, so the wage gap between domestic and foreign firms is smaller than that of the other linkages. The input provided by foreign firms contributes to both the net revenue of domestic firms and the reservation wages of workers.

According to Figure 6, skill premiums are greatest in the backward linkages and lowest in the forward linkages. An increase in foreign firm presence raises the skilled premium for all linkages. However, the increase in foreign capital leads to a sharper increase in the skill premium if the source of the increase in foreign capital is a reduction in the cost of foreign capital. In the forward linkages, the use of foreign capital as an input in domestic production reduces the gap between skilled and unskilled workers in the domestic firm. However, in the backward linkages, the skill premium is higher than that of forward linkages. In the backward linkages, foreign firms have used domestic production as an input, which will raise the wages of skilled workers in the domestic firm extensively but does not make a huge change in unskilled wages. In the forward linkages, as foreign presence contributes to both the production of low-skill intensive and high-skill intensive domestic firms, the wages of low-skilled workers become higher than those of the backward

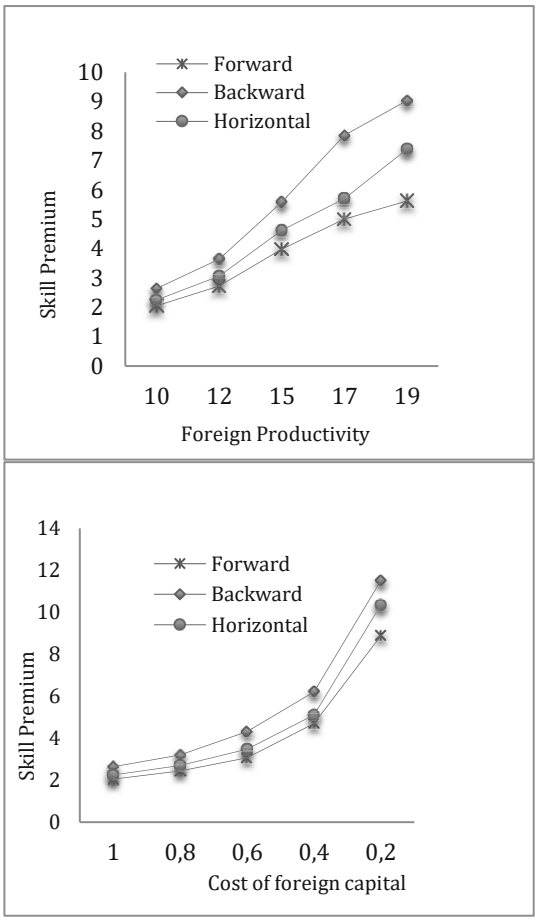
linkages. Thus, the skill premium is lowest for the forward linkages and highest for the backward linkages. The skill premium for the horizontal linkages lies between the backward and forward linkages.

Figure 5. Foreign firm premium (backward, forward and horizontal linkages)



Source: Author's own elaboration

Figure 6. Skill premium (backward, forward and horizontal linkages)



Source: Author's own elaboration

3.3. Unemployment

Job creation lies at the heart of the development agenda. In this context, many countries offer incentives to attract foreign firms to benefit from their contribution to job creation. In part, host countries aimed to reduce

unemployment rates through the diversification of production activities by foreign firms. However, only a few empirical studies have focused on the link between foreign firm activities and unemployment rates. The interaction between FDI and unemployment rates varies significantly from country to country (depending on the structure of the economy and on the type of received FDI) and from period to period (Srat et al., 2015). Rizvi and Nishat (2009) demonstrated that FDI does not create a direct impact on employment opportunities in India, China and Pakistan. Mucuk and Demirsel et al. (2013) showed that FDI increases the unemployment rate in Turkey and Argentina but reduces it in Thailand.

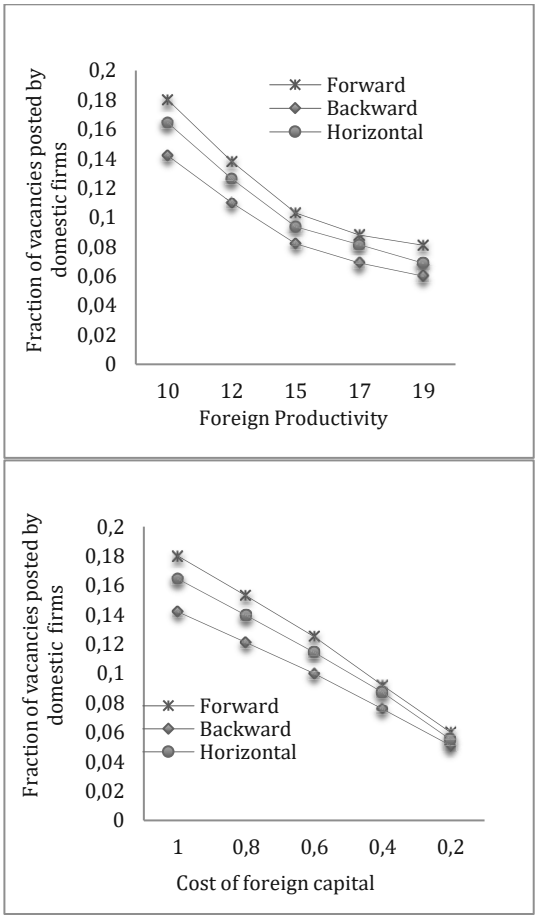
The search and matching model allows us to study the impact of foreign firms on the unemployment rates of both low-skilled and high-skilled workers by considering the role of linkages established between domestic and foreign firms. Our aim, to fill the void in the literature, to construct a search and matching framework to discuss the effect of foreign presence on local labor markets, is to have a function for the unemployment rate. Within this framework, we can solve for the unemployment rate u as a function of labor market tightness (θ) and the job destruction rate δ with the help of equation (2), which gives

$$u\sigma = \frac{\delta\mu}{\delta + \eta m(\theta)} \tag{31}$$

$$u(1-\sigma) = \frac{\delta(1-\mu)}{\delta + m(\theta)} \tag{32}$$

where unemployment is positively related to the job destruction rate and negatively related to labor market tightness. In fact, equations (31) and (32) for unemployment rates are implicitly given because $\theta = \frac{v_D + v_F}{u}$. Thanks to the numerical solution in determining the unemployment rates of both low-skilled and high-skilled workers by highlighting the equilibrium values for the mass of local vacancies, the mass of foreign vacancies and the share of low-skilled workers in the unemployment pool. According to equations (31) and (32), an increase in foreign firm presence has no direct impact on the unemployment rates of low-skilled and high-skilled workers, but it has an indirect impact on job creation by domestic and foreign firms depending on the buyer-supplier linkages established between domestic and foreign firms.

Figure 7. Domestic vacancy creation

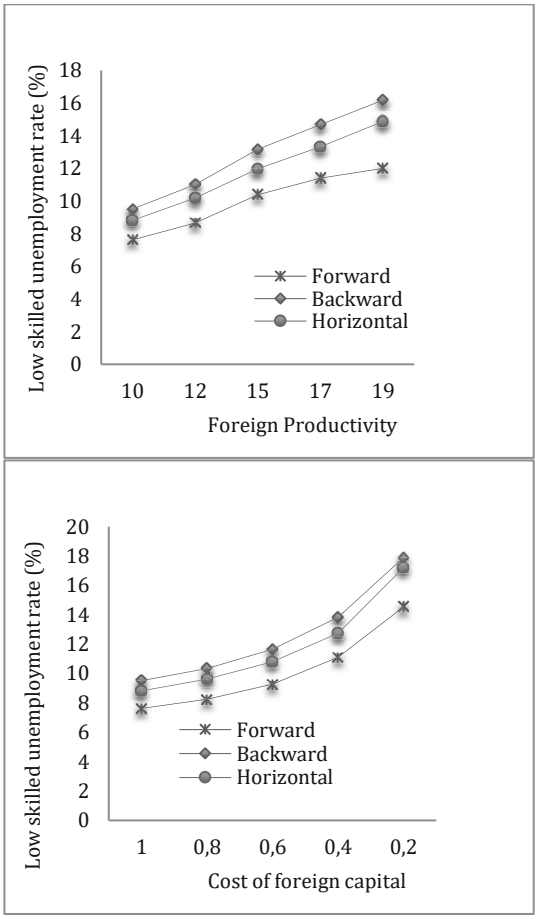


Source: Author's own elaboration

Figure 7 presents the domestic vacancy creation upon the entry of foreign firms. Both schedules in Figure 7 have revealed the crucial role of buyer supplier linkages in job creation. The share of domestic vacancies is highest if multinationals supply intermediate inputs to domestic firms. That is, at the forward level, foreign firms are more likely to support domestic job creation. However, if domestic firms are suppliers of multinationals, the fraction of vacancies posted by domestic firms will be lowest.

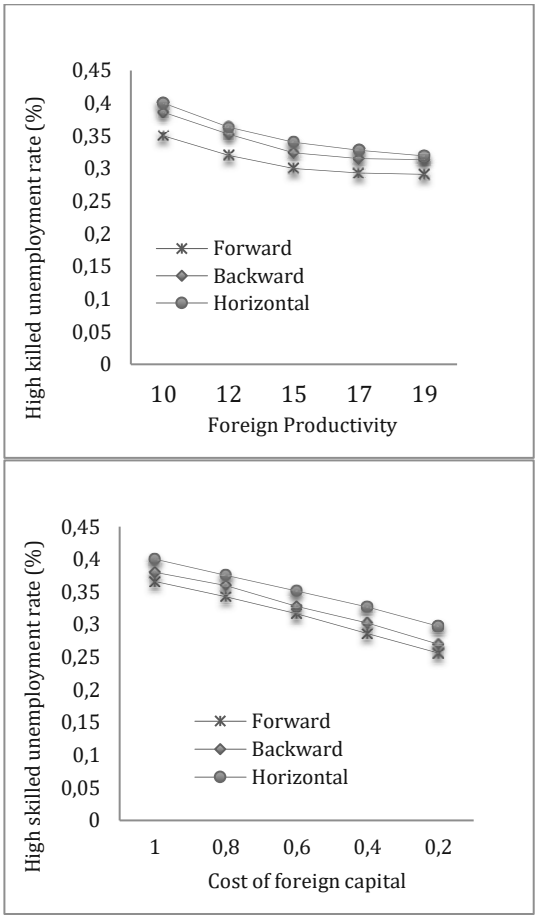
Figure 8 and Figure 9 display the unemployment rates of low-skilled workers and high-skilled workers for different linkages, respectively. The unemployment rate of low-skilled workers fluctuates approximately 6% to 10% for the forward linkages, while it fluctuates approximately 10% to 16% at the backward level. The horizontal linkages are approximately 8% to 16%. Thus, the first observation from Figure 8 is that the impact of foreign presence on the unemployment rate depends on the type of linkages. The low-skilled unemployment rate is highest if backward linkages take place and lowest if forward linkages take place. Particularly, at the backward level, as foreign firms force domestic firms to produce more advanced and higher-quality inputs for foreign production, job creation is mainly located around high-skilled workers rather than low-skilled workers. In fact, labor market competition toward high-skilled workers and increased pressure for skill-intensive production worsen the labor market conditions for low-skilled workers by deterring job creation for them. Furthermore, at the backward level, the unemployment rate of high-skilled workers is higher than that of the forward level. This is partly captured by the fact that wages paid to high-skilled workers at the backward level are greater than those paid to high-skilled workers at the forward level. Because the cost of high-skilled workers is higher in the backward linkages, one can expect higher unemployment rates for high-skilled workers. Figure 9 shows that unemployment rates for high-skilled workers are highest for horizontal linkages. If domestic and foreign firms compete in the same sector, there may be no improvement in the labor market conditions for high-skilled workers in terms of job creation. As they act in the same sector, foreign firms may prefer to preserve their firm-specific assets and may not share new knowledge and technology with domestic firms, and there will be limited job opportunities for high-skilled workers. Actually, the literature has mentioned the lack of productivity spillovers and workers' mobility for horizontal linkages. However, if buyer supplier linkages take place either at the backward level or at the forward level, the corresponding unemployment rate for high-skilled workers will be lower than that of the horizontal linkages. Alternately, at the forward level, new and better quality inputs produced by foreign firms to be used in the production of domestic firms make domestic firms more competitive and enable them to expand production and employment. Therefore, the unemployment rates of both low-skilled and high-skilled workers are lowest for the forward linkages.

Figure 8. Unemployment rate of low-skilled workers



Source: Author's own elaboration

Figure 9. Unemployment rate of high-skilled workers



Source: Author's own elaboration

An increase in foreign capital via productivity gains or a cost reduction increases the unemployment rate of low-skilled workers but lowers the unemployment rate of high-skilled workers for all linkages. A sharper increase in the unemployment rate of low-skilled workers is associated with a lower cost of foreign capital. In other words, an increase in foreign presence raises the unemployment rate of low-skilled workers but reduces the unemployment rate of high-skilled workers. In summary, frictions in the labor market and

interaction between buyer-supplier linkages in production have a significant impact on the unemployment rates of low-skilled and high-skilled workers. Domestic firms need to establish either backward or forward linkages if they aim to reduce the unemployment rate of high-skilled workers. Furthermore, if domestically produced goods are used as an input for the foreign firm, there will be lower domestic jobs and a higher unemployment rate.

Throughout the paper, for the sensitivity of the numerical simulations, foreign presence is captured by both productivity gains and a reduction in the cost of capital. Despite the reason behind a rise in foreign presence, wage and unemployment implications are quite the same for channels. Only sharper movements are experienced if the cost of foreign capital is reducing from 0.4 to 0.2.

In summary, foreign presence either through productivity gains or a reduction in the foreign cost of capital has important effects on the domestic labor market depending on the linkages established between domestic and foreign firms.

4. Conclusions

A unifying theoretical framework that incorporates realistic labor market imperfections and productivity spillovers is constructed to study the wage and unemployment implications of increased foreign presence depending on the type of linkages established between domestic and foreign firms. Wage determination follows a usual search model framework where workers can move from being unemployed to being employed in either a domestic or a foreign firm. Frictions in labor mobility point to wage determination in both domestic and foreign firms as a weighted average of the marginal revenue product of the worker and the reservation wage, where the weights depend on labor market imperfections.

The findings of the search and matching model reveal that foreign firms pay higher wages for all types of linkages and increase in foreign firm presence either by an increase in foreign productivity or a reduction in the cost of foreign capital bids up the wages paid to high-skilled workers for both domestic and foreign firms. This is similar to the empirical findings offered by Aitken et al. (1996) and Lipsey and Sjöholm (2004). Domestic firms that are suppliers of foreign firms have to pay more for the high-skilled workers not only to meet the production requirements set by multinationals but also to match with the high-skilled workers in the labor market. However, the

contribution of foreign presence to the formation of high-skilled workers is very limited for horizontal linkages, as multinationals do not want to share new knowledge and technology with domestic firms as they act in the same sector (see Munoz-Bullon and Sanchez-Bueno, 2013). If foreign firms are suppliers of intermediate inputs for domestic firms, the wages of low-skilled workers in the domestic firm record a slight decrease following the increase in foreign capital via productivity gains or a cost reduction. However, an increase in foreign presence has a negligible positive impact on the wages of low-skilled workers in the domestic firm if there are forward linkages. That is, low-skilled workers are better off only if foreign firms offer cheap and advanced inputs to domestic firms. Another observation from a numerical example suggests that the wage inequality between high-skilled workers and low-skilled workers is higher if domestic firms are suppliers of multinationals, whereas it is lower when multinationals are suppliers of domestic firms. Within this context, the theoretical findings of the paper support the empirical evidence documented in the literature (Hoi and Pomfret, 2010 and Pittiglio et al., 2015).

Furthermore, an increase in foreign presence lowers the unemployment rate of high-skilled workers and raises the unemployment rate of low-skilled workers. The results also suggest that unemployment rates for low- and high-skilled workers are lowest for forward linkages. At the forward level, foreign firms make higher-quality and lower-price inputs available to domestic producers, which allows domestic firms to enrich employment opportunities by encouraging domestic job creation, thereby reducing the unemployment rate of both types of workers. At the backward level, foreign firms force domestic firms to produce high-quality inputs, which will deter job creation for low-skilled workers; therefore, the greatest unemployment rates for low-skilled workers are experienced by backward linkages. Alternately, the highest unemployment rates for high-skilled workers exist for horizontal linkages. When foreign and domestic firms compete for the domestic final good production sector, foreign firms may have an incentive to restrict labor turnover to prevent technology leakage.

In summary, recipient countries should evaluate the different effects of different linkages before providing incentives for multinationals. Backward linkages generate the highest wage inequality between high-skilled and low-skilled workers and do not support domestic vacancy creation in the recipient economy. It supports the well-being of high-skilled workers and reduces the unemployment rate of high-skilled workers. If policy makers aim to fight

wage inequality, improve the well-being of low-skilled workers and support domestic vacancy creation for both high-skilled and low-skilled workers, they should support the establishment of forward linkages between multinationals and domestic firms.

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APPENDIX

In a perfectly competitive market, the profit-maximizing amount of capital for different linkages is represented as follows:

$$k_F^{Back} = \left(\frac{p_F}{P_{kF}}\alpha_F s_h \mathrm{k}_{\mathrm{Dm}}^{\alpha_\mathrm{m}\gamma_\mathrm{m}} s_m^{\gamma_\mathrm{m}} \mathrm{k}_{\mathrm{Dl}}^{\alpha_\mathrm{l}\gamma_\mathrm{l}} s_l^{\gamma_\mathrm{l}}\right)^{1/1-\alpha_F}$$

$$k_{Dm}^{Back} = \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m \mathrm{s}_\mathrm{m}\right)^{1/1-\alpha_\mathrm{m}}$$

$$k_{Dl}^{Back} = \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l \mathrm{s}_\mathrm{l}\right)^{1/1-\alpha_\mathrm{l}}$$

$$k_F^{Forw} = \left(\frac{p_F}{P_{kF}}\alpha_F s_h\right)^{1/1-\alpha_F}$$

$$k_{Dm}^{Forw} = \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m \mathrm{s}_\mathrm{m}\right)^{1/1-\alpha_\mathrm{m}} \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\propto_m)}$$

$$k_{Dl}^{Forw} = \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l \mathrm{s}_\mathrm{l}\right)^{1/1-\alpha_\mathrm{m}} \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\phi_F/(1-\alpha_F)(1-\alpha_l)} s_h^{\phi_F/(1-\alpha_F)(1-\propto_l)}$$

$$k_F^{Horz} = \left(\frac{p_F}{P_{kF}}\alpha_F s_h\right)^{1/1-\alpha_F}$$

$$k_{Dm}^{Horz} = \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m \mathrm{s}_\mathrm{m}\right)^{1/1-\alpha_\mathrm{m}}$$

$$k_{Dl}^{Horz} = \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l \mathrm{s}_\mathrm{l}\right)^{1/1-\alpha_\mathrm{l}}$$

The outputs of foreign and domestic firms generated by high-skilled and low-skilled workers for all types of linkages are given as follows:

$$y_{Dm}^{Back} = \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m} \quad |$$

$$y_{Dl}^{Back} = \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}$$

$$y_F^{Back} = \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/1-\alpha_F} s_h^{1/1-\alpha_F} \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m\gamma_m/(1-\alpha_m)(1-\alpha_F)} (s_m)^{\gamma_m/(1-\alpha_m)(1-\alpha_F)} \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l\gamma_l/(1-\alpha_l)(1-\alpha_F)} (s_l)^{\gamma_l/(1-\alpha_l)(1-\alpha_F)}$$

$$y_{Dm}^{Forw} = \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m} \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\alpha_m)}$$

$$y_{Dl}^{Forw} = \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l} \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\phi_F/(1-\alpha_F)(1-\alpha_l)} s_h^{\phi_F/(1-\alpha_F)(1-\alpha_l)}$$

$$y_F^{Forw} = \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}$$

$$y_F^{Horz} = \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}$$

$$y_{Dm}^{Horz} = \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}$$

$$y_{Dl}^{Horz} = \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}$$

Then, the net revenues of foreign and domestic firms generated by high-skilled and low-skilled workers for all types of linkages are:

$$R_F^{Back} = p_F(1-\alpha_F-\gamma_m-\gamma_l)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/1-\alpha_F} s_h^{1/1-\alpha_F} \left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m\gamma_m/(1-\alpha_m)(1-\alpha_F)} (s_m)^{\gamma_m/(1-\alpha_m)(1-\alpha_F)} \left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l\gamma_l/(1-\alpha_l)(1-\alpha_F)} (s_l)^{\gamma_l/(1-\alpha_l)(1-\alpha_F)}$$

$$R_{Dm}^{Back} = p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}$$

$$R_{Dl}^{Back} = p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}$$

$$R_F^{Forw} = p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}$$

$$R_{Dm}^{Forw} = p_{Dm}(1-\alpha_m-\kappa_F)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m} \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\alpha_m)}$$

$$R_{Dl}^{Forw} = p_{Dl}(1-\alpha_l-\phi_F)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l} \left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\phi_F/(1-\alpha_F)(1-\alpha_l)} s_h^{\phi_F/(1-\alpha_F)(1-\alpha_l)}$$

$$R_F^{Horz} = p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}$$

$$R_{Dm}^{Horz} = p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}$$

$$R_{Dl}^{Horz} = p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}$$

For simplicity, wages under forward, backward and horizontal linkages are represented as follows:

$$w_F^{Backw} = \beta p_F\left(1-\alpha_F-\gamma_m-\gamma_l\right)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/1-\alpha_F} s_h^{1/1-\alpha_F}\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m\gamma_m/(1-\alpha_m)(1-\alpha_F)}(s_m)^{\gamma_m/(1-\alpha_m)(1-\alpha_F)}\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l\gamma_l/(1-\alpha_l)(1-\alpha_F)}(s_l)^{\gamma_l/(1-\alpha_l)(1-\alpha_F)}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}+(1-\eta)p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/1-\alpha_F} s_h^{1/1-\alpha_F}\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m\gamma_m/(1-\alpha_m)(1-\alpha_F)}(s_m)^{\gamma_m/(1-\alpha_m)(1-\alpha_F)}\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l\gamma_l/(1-\alpha_l)(1-\alpha_F)}(s_l)^{\gamma_l/(1-\alpha_l)(1-\alpha_F)}\right]}{r+\delta+\beta m(\theta)} \quad \text{(A1)}$$

$$w_{Dm}^{Backw} = \beta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}+(1-\eta)p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/1-\alpha_F} s_h^{1/1-\alpha_F}\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m\gamma_m/(1-\alpha_m)(1-\alpha_F)}(s_m)^{\gamma_m/(1-\alpha_m)(1-\alpha_F)}\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l\gamma_l/(1-\alpha_l)(1-\alpha_F)}(s_l)^{\gamma_l/(1-\alpha_l)(1-\alpha_F)}\right]}{r+\delta+\beta m(\theta)} \quad \text{(A2)}$$

$$w_{Dl}^{Backw} = \beta p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}+(1-\beta)\frac{m(\theta)\eta\beta p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}}{r+\delta+\beta m(\theta)\eta} \quad \text{(A3)}$$

$$w_F^{Forw} = \beta p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\alpha_m)}+(1-\eta)p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}\right]}{r+\delta+\beta m(\theta)} \quad \text{(A4)}$$

$$w_F^{Forw} = \beta p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\alpha_m)}+(1-\eta)p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}\right]}{r+\delta+\beta m(\theta)} \quad \text{(A4)}$$

$$w_{Dm}^{Forw} = \beta p_{Dm}(1-\alpha_m-\kappa_F)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\alpha_m)}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\kappa_F/(1-\alpha_F)(1-\alpha_m)} s_h^{\kappa_F/(1-\alpha_F)(1-\alpha_m)}+(1-\eta)p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}\right]}{r+\delta+\beta m(\theta)} \quad \text{(A5)}$$

$$w_{Dl}^{Forw} = \beta p_{Dl}\left(1-\alpha_l-\phi_F\right)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\Phi_F/(1-\alpha_F)(1-\alpha_l)} s_h^{\Phi_F/(1-\alpha_F)(1-\alpha_l)}+(1-\beta)\frac{m(\theta)\eta\beta p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F\Phi_F/(1-\alpha_F)(1-\alpha_l)} s_h^{\Phi_F/(1-\alpha_F)(1-\alpha_l)}}{r+\delta+\beta m(\theta)\eta} \quad \text{(A6)}$$

$$w_F^{Horz} = \beta p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}+(1-\eta)p_F(1-\alpha_F)\left(\frac{p_F}{P_{kF}}\alpha_F\right)^{\alpha_F/(1-\alpha_F)} s_h^{1/(1-\alpha_F)}\right]}{r+\delta+\beta m(\theta)} \quad \text{(A7)}$$

$$w_{Dm}^{Horz} = \beta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}+(1-\beta)\frac{m(\theta)\beta\left[\eta p_{Dm}(1-\alpha_m)\left(\frac{p_{Dm}}{P_{kDm}}\alpha_m\right)^{\alpha_m/1-\alpha_m} s_m^{1/1-\alpha_m}+(1-\eta)(1-\alpha_F)p_F k_F^{\alpha_F} s_h\right]}{r+\delta+\beta m(\theta)} \quad \text{(A8)}$$

$$w_{Dl}^{Horz} = \beta p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}+(1-\beta)\frac{m(\theta)\eta\beta p_{Dl}(1-\alpha_l)\left(\frac{p_{Dl}}{P_{kDl}}\alpha_l\right)^{\alpha_l/1-\alpha_l} s_l^{1/1-\alpha_l}}{r+\delta+\beta m(\theta)\eta} \quad \text{(A9)}$$

Table 2. Summary of findings

Absolute wages	
The wage gap between skilled workers in foreign and domestic firms.	$w_F^{Forw} > w_{Dm}^{Forw}$ $w_F^{Backw} > w_{Dm}^{Backw}$ $w_F^{Horz} > w_{Dm}^{Horz}$
The wage gap between skilled workers in different linkages.	$w_F^{Backw} > w_F^{Forw} \cong w_F^{Horz}$ $w_{Dm}^{Backw} > w_{Dm}^{Forw} \cong w_{Dm}^{Horz}$
The wage gap between unskilled workers in different linkages.	$w_{Dl}^{Forw} > w_{Dl}^{Backw} \cong w_{Dl}^{Horz}$
Relative Wages	
Foreign firm premium	$\frac{w_F^{Backw}}{w_{Dm}^{Backw}} > \frac{w_F^{Horzw}}{w_{Dm}^{Horzw}} > \frac{w_F^{Forw}}{w_{Dm}^{Forw}}$
Skill premium	$\frac{w_{Dm}^{Backw}}{w_{Dl}^{Backw}} > \frac{w_{Dm}^{Horzw}}{w_{Dl}^{Horzw}} > \frac{w_{Dm}^{Forw}}{w_{Dl}^{Forw}}$
The impact of foreign presence	
Increase in foreign productivity	
Absolute Wages	$\frac{\partial w_F^{Backw}}{\partial s_h} > 0, \frac{\partial w_F^{Forw}}{\partial s_h} > 0, \frac{\partial w_F^{Horzw}}{\partial s_h} > 0$ $\frac{\partial w_{Dm}^{Backw}}{\partial s_h} > 0, \frac{\partial w_{Dm}^{Forw}}{\partial s_h} > 0, \frac{\partial w_{Dm}^{Horzw}}{\partial s_h} > 0$ $\frac{\partial w_{Dl}^{Backw}}{\partial s_h} = 0, \frac{\partial w_F^{Forw}}{\partial s_h} > 0, \frac{\partial w_F^{Horzw}}{\partial s_h} = 0$
Decrease in the cost of foreign capital	
Absolute Wages	$\frac{\partial w_F^{Backw}}{\partial p_{kF}} > 0, \frac{\partial w_F^{Forw}}{\partial p_{kF}} > 0, \frac{\partial w_F^{Horzw}}{\partial p_{kF}} > 0$ $\frac{\partial w_{Dm}^{Backw}}{\partial p_{kF}} > 0, \frac{\partial w_{Dm}^{Forw}}{\partial p_{kF}} > 0, \frac{\partial w_{Dm}^{Horzw}}{\partial p_{kF}} > 0$ $\frac{\partial w_{Dl}^{Backw}}{\partial p_{kF}} = 0, \frac{\partial w_F^{Forw}}{\partial p_{kF}} > 0, \frac{\partial w_F^{Horzw}}{\partial p_{kF}} = 0$

Increase in foreign productivity	
Foreign firm premium	$\frac{\partial \frac{w_F^{Backw}}{w_{Dm}^{Backw}}}{\partial s_h} > 0, \frac{\partial \frac{w_F^{Forw}}{w_{Dm}^{Forw}}}{\partial s_h} > 0, \frac{\partial \frac{w_F^{Horzw}}{w_{Dm}^{Horzw}}}{\partial s_h} > 0$
Skill premium	$\frac{\partial \frac{w_{Dm}^{Backw}}{w_{Dl}^{Backw}}}{\partial s_h} > 0, \frac{\partial \frac{w_{Dm}^{Forw}}{w_{Dl}^{Forw}}}{\partial s_h} > 0, \frac{\partial \frac{w_{Dm}^{Horzw}}{w_{Dl}^{Horzw}}}{\partial s_h} > 0$
Decrease in the cost of foreign capital	
Foreign firm premium	$\frac{\partial \frac{w_F^{Backw}}{w_{Dm}^{Backw}}}{\partial p_{kF}} > 0, \frac{\partial \frac{w_F^{Forw}}{w_{Dm}^{Forw}}}{\partial p_{kF}} > 0, \frac{\partial \frac{w_F^{Horzw}}{w_{Dm}^{Horzw}}}{\partial p_{kF}} > 0$
Skill premium	$\frac{\partial \frac{w_{Dm}^{Backw}}{w_{Dl}^{Backw}}}{\partial p_{kF}} > 0, \frac{\partial \frac{w_{Dm}^{Forw}}{w_{Dl}^{Forw}}}{\partial p_{kF}} > 0, \frac{\partial \frac{w_{Dm}^{Horzw}}{w_{Dl}^{Horzw}}}{\partial p_{kF}} > 0$

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Canan Eryiğit[*] - Mehmet Eryiğit[†]

THE DIFFUSION PROCESS OF BITCOIN

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Abstract

This article reports the results of an investigation of the diffusion of cryptocurrencies. The Bass diffusion model is used to estimate the diffusion patterns of Bitcoin. In addition, the size and time intervals of adopter categories are examined. The unit of analysis is quarterly data of new wallets. The data covered 37 quarterly observations for the periods from the last quarter of 2011 to the second quarter of 2020. The parameters of the Bass model are estimated through Ordinary Least Squares (OLS) estimations. The diffusion curve of Bitcoin is developed based on the estimated parameters. The results indicate that the diffusion of Bitcoin has passed early adoption and takeoff periods and is close to maturity. The estimated diffusion process indicates that innovators, early adopters, early majority, late majority, and laggards had adopted Bitcoin. The findings may guide communication decisions with different types of investors and government regulation plans.

JEL CLASSIFICATION: G40; M30; O16; O30.

KEYWORDS: INNOVATION DIFFUSION; CRYPTOCURRENCY; BITCOIN; BASS MODEL; ADOPTER CATEGORIES.

[*] Hacettepe University, Department of Business Administration, Hacettepe University, Ankara, Turkey. Email canand@hacettepe.edu.tr.
[†] Bolu Abant Izzet Baysal University Department of Business Administration, Bolu Abant Izzet Baysal University, Bolu, Turkey. Email: eryigit_m@ibu.edu.tr.

1. Introduction

Blockchain technology has changed the financial system and business operations through the creation of cryptocurrencies. Cryptocurrencies have garnered the attention of investors (Giudici et al., 2020) by offering an alternative to existing payment and saving methods. Accordingly, the cryptocurrencies market has reached $194 billion market capitalization by 2020. There were 412 wallets in January 2012, whereas almost 46 million wallets existed by March 2020.[1]

The literature on cryptocurrency has been increasing, mainly focusing on Bitcoin (Giudici et al., 2020). However, the cryptocurrency research field is regarded as being in the early stages of growth (Caporale & Plastun, 2019; Park & Park, 2020). Generally, studies have focused on the following issues: price and volatility of cryptocurrencies (Caporale & Plastun, 2019; Ciaian et al., 2016; Li and Wang, 2017; Salamat et al., 2020), relationships across cryptocurrencies (Dey et al., 2020; Ji et al., 2019; Kyriazis, 2019; Yi et al., 2018), security, and regulations (Andriole, 2020; Grobys et al., 2020). An examination (Giudici et al., 2020) of the Scopus database showed that the studies on cryptocurrencies are primarily from the areas of computer science, engineering, and mathematics. The share of the studies in the areas of social sciences (Economics, Econometrics & Finance and Business, Management & Accounting) is lower. Therefore, the literature mostly focused on the technical side of cryptocurrencies.

However, understanding the characteristics of the market and users in the market is essential for developing regulations and expansion plans for cryptocurrency. Regarding this notion, there are a few studies (Mazambani & Mutambara, 2019; Zhao et al., 2020) examining the diffusion process and the factors affecting the adoption of cryptocurrencies. Most of these studies were conducted at the individual level as they focus on the adoption behavior of individual investors. However, a market-level understanding of the development of cryptocurrencies is essential. Estimating the diffusion rate and trends is important in assisting critical decisions, such as the timing of technology modification, appropriate communication channels with potential investors, and the cost of mining. In addition, digital currencies create value; only people are willing to use them for transactions and exchange purposes (Mas & Chuen, 2015). Accordingly, understanding the adoption of

[1] www.coinmarketcap.com, accessed April 16, 2020

cryptocurrencies and how it is diffused in the market is crucial for valuation. However, we were unable to identify an empirical study presenting a comprehensive view of the market. Park & Park (2020) also supported this gap, indicating the lack of a holistic picture of the market with quantitative data.

Based on these points, this study aims to investigate the diffusion process of Bitcoin through innovation diffusion models. Thus, the remainder of the article is organized as follows. In the following section, we examine the cryptocurrency market and innovation diffusion models, along with a review of empirical studies. Afterwards, the methodology of the study with the details of the model and data is examined. The findings of the study are presented and discussed in the last section, which concludes the article.

2. Conceptual Framework

2.1. Cryptocurrencies

"Cryptocurrencies are peer-to-peer electronic cash systems that allow online payments to be sent directly from one party to another without going through a financial institution" (Corbet, Lucey, Urquhart, & Yarovaya, 2019:182). In other words, cryptocurrencies are peer-to-peer digital transfers without any certification of third-party institutions (Giudici et al., 2020). In total, 12 cryptocurrencies (such as Ripple, Litecoin, EOS) currently have market capitalization values greater than $170 billion. Those currencies, in total, constitute 89% of the total cryptocurrency market. However, more than five thousand cryptocurrencies exist. The prices of those cryptocurrencies have ranged from $0.000085 (the price of WİNq on 15.04.2020) to $6794 (the price of Bitcoin on 15.04.2020). These cryptocurrencies can be traded in over twenty thousand different markets[2]. BTC is the leading cryptocurrency. Hence, the market capitalization of Bitcoin is $124 billion by 2020, representing 64% of the total market. Ethereum is the second-largest cryptocurrency, representing 9% of the overall market with a market capitalization value of $17 billion. Bitcoin, a type of cryptocurrency, is defined as a "purely digital record of ownership over a certain quantity of monetary value" (Mas & Chuen, 2015). Bitcoin (BTC) represents value as it

[2] www.coinmarketcap.com, accessed April 16, 2020

is tradable through a Bitcoin network (Mas & Chuen, 2015).

Despite this growth in the market, it is stated that the adoption of cryptocurrencies remains in its infancy due to technological, societal, and governmental barriers (Schipor, 2019). The regulations and market penetration of cryptocurrencies constitute severe uncertainties (Hui et al., 2020).

On the other hand, cryptocurrencies may be regarded as safe heavens due to the following characteristics: independence from monetary policy, a role as a store of value, and limited correlation with traditional assets (Conlon & McGee, 2020). Additionally, BTC provides some benefits to users. It offers fast transactions at lower costs, even for cross-border transfers (Nian & Chuen, 2015). In addition, BTC transactions are more secure due to transaction verification. The systematic verification process eliminates the chances of disputes occurring (Salamat et al., 2020). Accordingly, BTC transactions are irreversible, which also prevents fraud in the chargeback process. In addition, Bitcoin prevents identity theft because transactions do not require personal information. On the other hand, there is a likelihood of private key theft. BTC is also accepted to have the potential for future innovations (Nian & Chuen, 2015).

2.2. Innovation Diffusion Models

The diffusion of innovation has been defined as "the process by which that innovation is communicated through certain channels over time among the members of a system" (Rogers, 1983). In other words, "the theory of diffusion of innovations explains how, why, and at what rate new ideas and technology gains momentum and diffuses through a social system" (Vincent & Evans, 2019:261). Innovation diffusion models can be used to identify the adoption rate and to forecast the future adoption of an innovation. Additionally, these models are used to develop adopter categories that are generated based on consumers' time of adoption (Rogers, 1983).

The Bass (1969) diffusion model has been widely used to forecast the adoption of new products (Kavak & Demirsoy, 2009). According to the model, the probability of the adoption of a new product at time t is an increasing linear function of the number of previous adopters. The Bass diffusion model proposes that potential adopters of an innovation are influenced by two means of communication: mass media communication and word of mouth communication. Accordingly, the model categorizes adopters

into two categories: innovators who are affected by mass media communication and imitators who are influenced by word of mouth communication. In the model, the coefficient of innovation measures the effect of mass media communication, and the coefficient of imitation measures the impact of word of mouth communication (Bass, 1969; Bass & Bultez, 1982).

The other widely used diffusion model is the model offered by Rogers (1983). The Rogers diffusion model assumes that diffusion of a new product follows a normal distribution. It is possible to determine five adopter categories, namely, innovators, early adopters, early majority, late majority, and laggards, by using the mean and standard deviation of the distribution (Rogers, 1983). Mahajan, Muller, & Srivastava (1990) combined Bass and Rogers models to generate adopter categories. Many studies (Adams et al., 2019; Bridges, E., & Ellis, 1997; Mahajan et al., 1990; Martínez & Polo, 1996; Reinhardt & Gurtner, 2015) have been devoted to identifying and describing adopter categories. Those studies examined various variables to understand the characteristics of adopters, such as demographic variables, socioeconomic variables, product-specific variables, and personality values (Kavak & Demirsoy, 2009).

Diffusion models have been applied to various product categories from tangibles to services, as well as financial innovations. Studies have generally investigated the diffusion process of durable innovations, such as electric vehicles (Li et al., 2017; Massiani & Gohs, 2015), medicines (Dunn et al., 2012), consumer durables (Martínez & Polo, 1996), automobiles (Meir, 1981; Xia, 2017), and personal computers (Mahajan et al., 1990). The validity of the Bass model was also supported for services, such as mobile communication and mobile services (Chandra & Yadav, 2013; Kumar et al., 2007) and health services (Bridges, E., & Ellis, 1997). Moreover, studies have employed various types of diffusion models to estimate adoption levels, such as compartmental diffusion models, microlevel models, and technology substitution models (Abedi, 2019; Kumar, 2015; Laciana et al., 2013).

Diffusion models have also been validated for financial innovations in a few studies. For instance, Kavak & Demirsoy (2009) studied the diffusion of online banking in Turkey and showed that the Bass model fits well with the data. Similarly, Srivastava et al. (1985) used diffusion models to forecast the adoption of investment alternatives. The diffusion pattern of investment funds

was also examined using of diffusion models (Marszk et al., 2017). In addition, Marszk & Lechman (2018) investigated the diffusion of exchange-traded funds (ETFs) in Japan and South Korea using diffusion models. They extended their study to 32 emerging and developed countries in their further research (Marszk & Lechman, 2019). Another study (Mare et al., 2019) investigated the diffusion process of life insurance among Romanian consumers.

There are also studies focusing on the adoption and diffusion of blockchain technology or cryptocurrencies. For instance, Janssen et al. (2019) investigated the factors affecting the adoption of cryptocurrencies. Their review of 31 papers showed three main factors influencing the adoption of cryptocurrencies, namely, institutional factors, technical factors, and market factors. Institutional factors are norms and culture, regulations and legislation, and governance. Technical factors include information exchange and transactions, distributed ledgers, and shared infrastructure. Market factors affecting the adoption of cryptocurrencies cover market structure, contracts and agreements, and business process. Mazambani & Mutambara (2019) investigated the factors that influence the intention to adopt cryptocurrencies in accordance with the theory of planned behavior. The study was conducted on 269 students who are regarded as potential users of cryptocurrency. The results indicate that attitude and perceived behavioral control significantly positively influence adoption intention, whereas subjective norms have an insignificant negative effect. Zhao et al. (2020) investigated the adoption of blockchain technology in China with the use of online resources and interview methods. The study covered various types of investors ranging from Bitcoin investors to financial companies and governments. The results revealed that blockchain technology had evolved three stages of technology adoption: embryonic, early growth, and growth. Another study (Wang et al., 2016) investigated the blockchain maturity model and its adoption process and offered a three-stage adoption model, including feasibility study, development and operation phases.

The studies mentioned above examined the individual adoption behavior of cryptocurrency or blockchain technology. Thus, they provided evidence for individual-level adoption. Research on Bitcoin development and diffusion at the market level is lacking. Accordingly, this study aims to examine the diffusion process of Bitcoin. Regarding the studies (Kavak & Demirsoy, 2009; Mare et al., 2019; Marszk & Lechman, 2019; Srivastava et al., 1985) that applied diffusion models to financial innovations, diffusion of Bitcoin can be

estimated with the use of diffusion models.

3. Analytical Expressions

We defined the diffusion process of cryptocurrencies based on the Bass model and estimated the model by employing the following formulas (Schmittlein & Mahajan, 1982). Accordingly, the adoption rate at time t can be expressed as follows:

$$f(t) = \frac{dF(t)}{dt} = [p + qF(t)]\,[1 - F(t)] \quad (1)$$

F(t): the cumulative fraction of adopters at time t, f(t): the noncumulative fraction of adopters at time t, p: the coefficient of innovation, q: the coefficient of imitation.

$$n_t = \frac{dN(t)}{dt} = p[m - N_t] + \frac{q}{m} N_t[m - N_t] \quad (2)$$

N(t) = mF(t): cumulative number of adopters at time t, n(t) = mf(t): noncumulative number of adopters at time t, m: potential number of adopters

$$n(t) = pm + (q - p)N_{t-1} - \frac{q}{m} N_{t-1}^2 \quad (3)$$

$$n_t = \alpha_1 + \alpha_2 N_{t-1} + \alpha_3 N_{t-1}^2 \quad (4)$$

$$\alpha_1 = pm \quad (5)$$

$$\alpha_2 = q - p \quad (6)$$

$$\alpha_3 = -\frac{q}{m} \quad (7)$$

The Bass model proposes that "the probability that an initial purchase will be made at T given that no purchase has yet been made is a linear function of the number previous buyers" (Bass, 1969:216). Accordingly, the adoption rate and the number of adopters can be estimated via equations (1) and (2). Rearrangement of equation (2) yields equations (3 - 4). Regression analysis is used to estimate the regression coefficients α_1, α_2, and α_3 in equation 4. After regression coefficients are identified, p, q, and m can be estimated (Mahajan et al., 1990) using equations (8-10).

4. Data

The unit of analysis in diffusion models is the first purchase of the new product. In other words, adoption is measured as the first purchase (Bass & Bultez, 1982). Concerning this information, the study used the number of new wallets at a specific period as the first purchase. "Bitcoin wallets are software applications that facilitate the process of buying, selling, and managing one's Bitcoins" (Mas & Chuen, 2015). In other words, a user needs to store his Bitcoin in a wallet to be able to buy and sell them (Nian & Chuen, 2015). An individual holding a new wallet can be regarded as adopting the cryptocurrency since wallets function as storage of cryptocurrencies. Accordingly, the number of adopters equals the number of new wallets in each period.

We used the data for the new wallets of Bitcoin. Although different currencies are present in the market, these currencies were introduced to the market at different times. Thus, they are in different stages of diffusion (Papadimitriou, 2019).

The quarterly data was gathered from quandl.com. Thus, we used the new wallets assigned every three months. The data covered 37 quarterly observations for the periods of the last quarter of 2011 to the second quarter of 2020.

5. Results

The parameters of the Bass diffusion model were estimated by employing formulas 2 - 4. The ordinary least squares (OLS) estimation of equations 2 - 4 yielded the results presented in Table 1. According to the results (see Table 1), the Bass diffusion model has a satisfactory fit with an R^2 value of 0.76. Accordingly, α_1 = 4.26E+04, α_2 = 0.2207585, α_3 = -3.78E-09.

Table 1. OLS Estimation of the Bass Diffusion Model

	Coef.	Std. Err.	t	p
α_1	4.26E+04	18.23E+04	.23	.817
α_2	0.2207585	.0265216	8.32	.000
α_3	-3.78E-09.	5.86E-10	-6.45	.000

Sources: developed by the authors

Regression coefficients of α_1, α_2, and α_3 can be used to estimate parameters p, q, and m.

$$p = \frac{\alpha_1}{m} \tag{8}$$

$$q = -m\alpha_3 \tag{9}$$

$$m = \frac{-\alpha_2 - \sqrt{\alpha_2^2 - 4\alpha_1\alpha_3}}{2\alpha_3} \tag{10}$$

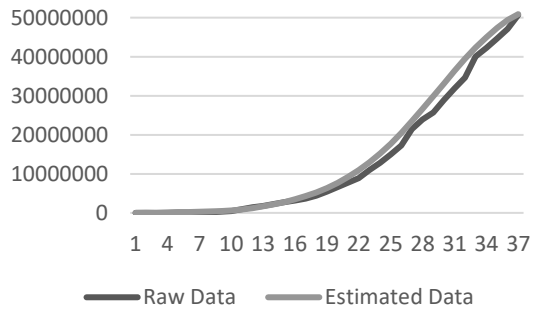
Employing these formulas resulted in the following parameter estimates:

p (the coefficient of innovation) = .00073,

q (the coefficient of imitation) = .2115.

The estimated values of p and q indicate that the adoption of Bitcoin is internal-dominant given that q > p (Dunn et al., 2012). According to the estimated parameters of the model, the cumulative adopter distribution for Bitcoin is presented in Figure 1.

Figure 1. Cumulative Adopter Distribution



Sources: developed by the authors

As shown in Figure 1, the diffusion of Bitcoin is consistent with the general S-shaped diffusion pattern. The general pattern of diffusion constitutes a period of slow increase at the beginning, which is called the early adoption or incubation period. This period is followed by more rapid growth, which is referred to as the take-off period. Afterwards, the number of adopters increases at a decreasing rate due to growth slowdown. This period is followed by maturity and saturation or plateau (Lechman 2015 as cited in Marszk & Lechman, 2019). According to Figure 1, Bitcoin has passed early adoption and takeoff periods. The diffusion is close to the maturity period, indicating that the rapid improvement has ended and that growth has slowed down.

We also estimated the size and time interval for adopter categories by employing the following formulas (Mahajan et al., 1990):

$$F(T^*) = \frac{1}{2} - \frac{p}{2q} \tag{11}$$

$$F(T_1) = F(T^*) - \frac{1}{\sqrt{12}} x \left(1 + \frac{p}{q}\right) \tag{12}$$

$$F(T_2) = F(T^*) + \frac{1}{\sqrt{12}} x \left(1 + \frac{p}{q}\right) \tag{13}$$

$$T_1 = -\frac{1}{p+q} ln[\left(2 + \sqrt{3}\right)\frac{p}{q} \tag{14}$$

$$T_2 = -\frac{1}{p+q} \ln\left[\frac{1}{\left(2 + \sqrt{3}\right)}\frac{p}{q}\right] \tag{15}$$

$$T^* = -\frac{1}{(p+q)} ln\left(\frac{p}{q}\right) \tag{16}$$

Then, the size of adopter categories can be calculated as follows (Mahajan et al., 1990);

Innovators = p
Early adopters = $F(T_1)$ - p
Early majority = $F - F$
Late majority = $F - F$
Laggards =$1 - F$

Estimated time intervals and sizes of adopter categories are presented in Table 2 and Figure 2. Accordingly, up to $t_{19.8,}$ the number of adopters increased rapidly, and this increase continued until $t_{25.7}$. In other words, the market grew

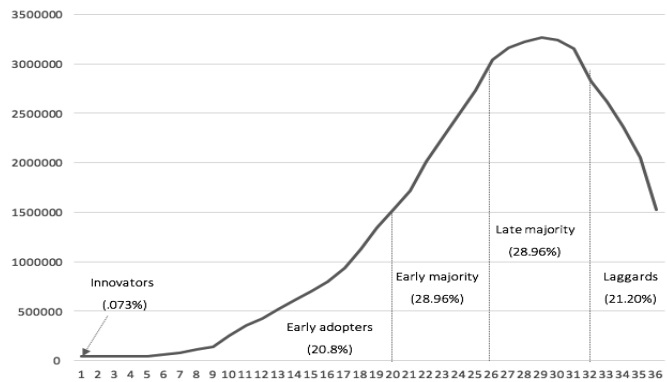
at an increasing rate until $t_{25.7}$. Later, the market increased slowly, and the number of adopters decreased at a decreasing rate.

Table 2. Estimated Time Intervals and Size of Adopter Categories

Adopter Category	Time Intervals		Size of Adopter Category (%)	
Innovators	T_0	0	p	.073
Early adopters	$0 \rightarrow T_1$	$0 \rightarrow 19.8$	$F(T_1) - p$	20.8
Early majority	$T_1 \rightarrow T^*$	$19.8 \rightarrow 25.7$	$F(T^*) - F(T_1)$	28.96
Late majority	$T^* \rightarrow T_2$	$25.7 \rightarrow 31.7$	$F(T_2) - F(T^*)$	28.96
Laggards	Beyond T_2	Beyond 31.7	$1 - F(T_2)$	21.20

Sources: developed by the authors

Figure 2. Estimated Noncumulative Adopter Distribution



Sources: developed by the authors

According to the sizes of adopter categories presented in Table 2 and Figure 2, innovators constitute a minor share in the market (.073%). The early adopters who adopted cryptocurrencies until $t_{25.7}$ represent approximately 21% of the market. The early majority constituted approximately 29% of the

market and adopted cryptocurrencies between $t_{25.7}$ and $t_{31.7}$. The late majority also constituted approximately 29% of the market, and these investors adopted cryptocurrencies after $t_{31.7}$. The laggards started to invest in cryptocurrencies after $t_{31.7}$ and covered almost 21% of the market.

6. Conclusion

In this study, the diffusion process of Bitcoin was analyzed employing the diffusion of innovation models. For this purpose, diffusion patterns, time intervals, and the size of adopter categories were identified for the quarterly data covering 2011-2020.

The estimation of the Bass diffusion model revealed that Bitcoin diffusion has passed the takeoff period, and market growth has slowed down. Accordingly, the diffusion of Bitcoin is close to the maturity period and market saturation. Then, less volatility in Bitcoin prices may be expected in the near future given that the more familiar is, the greater the likelihood of a less volatile Bitcoin value (Nian & Chuen, 2015).

Based on the phase of the diffusion process, different categories of adapters ranging from early adopters up to laggards are currently investing in the market. The estimated diffusion process of 37 periods indicated that innovators, early adopters, early majority, late majority, and laggards had adopted Bitcoin.

Consequently, interpersonal interaction has a prominent role in the diffusion process. However, estimated coefficients showed that Bitcoin is an internal-dominant innovation. Therefore, the likelihood of adopting cryptocurrencies independently from other investors is low. The internal-dominant characteristic of Bitcoin is consistent with the uncertainty associated with Bitcoin (Hui et al., 2020) and herding behavior. In herding, investors watch and imitate better-informed investors when high uncertainty is present (Giudici et al., 2020).

Thus, Bitcoin is adopted and grows by word of mouth communication. Accordingly, the increasing number of investors in cryptocurrencies and the higher earnings of those investors may encourage imitators who are risk averse. This notion is consistent with the view that a "fear of missing out," which is relevant for conventional assets, may also be valid for Bitcoin (Bouri et al., 2019). Consequently, positive posts on social media may play an essential role in the diffusion rate. Previous studies have suggested that the words and emotional content of social media influence investors (Nguyen et

al., 2020) and cryptocurrency prices and volumes (Burnie & Yilmaz, 2019; Wołk, 2019). In addition, social media users are interested in the currency exchange system and favor technology application issues (Park & Park, 2020).

The internal-dominant nature of the cryptocurrency may be due to illegal circulation and speculative actions. For instance, one-half of Bitcoin transactions (46%) are associated with illegal activity (Foley et al., 2019). Therefore, regulations ensuring cyber safety may diminish the perceived risk and may subsequently increase the rate of diffusion. However, laws and treatment toward cryptocurrencies vary across countries. Some countries consider cryptocurrencies as digital money, and others treat them as commodities. On the other hand, some countries forbid cryptocurrencies (Janssen et al., 2020).

Thus, the diffusion process is sensitive to government actions. Acceptance of cryptocurrency as an official transaction method may create a new peak or takeoff phase in the diffusion curve. Additionally, strict regulations on capital flows may lead people to Bitcoin to move money out of the country (Shahzad et al., 2019). Therefore, governments may have a positive role as regulators of the rate of speed of adoption. This notion is consistent with continual cocreation, indicating that innovation occurs through multiple cycles of diffusion and institutionalization (Vargo et al., 2020).

The study is not without limitations. Diffusion models use first purchases as a unit of analysis. Thus, we used the new wallets as first purchases. However, the same investor may have a new wallet in a different exchange market. It is not possible to discover the repetitiveness with the existing, reachable data sources. Additionally, the study focused on the diffusion, not the market growth, of Bitcoin. Accordingly, it should be noted here that the number of new wallets is not a predictor of the trade volume and market size. Future studies may examine market growth by estimating the product life cycle of Bitcoin. Thus, the growth of new wallets at a decreasing rate does not represent the trends in market size. In addition, the present study focused solely on the diffusion process of Bitcoin. Since Bitcoin is the leading currency and cryptocurrencies are highly correlated (Papadimitriou, 2019), this study findings may be generalized for cryptocurrencies. However, the diffusion process of other cryptocurrencies may still be examined in future studies. Moreover, the factors affecting the diffusion rate may be examined in future studies. Some of these factors may include social media, governmental

actions, and return on cryptocurrency.

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Tofig Aliyev*

THE IMPACT OF STOCK MARKET DEVELOPMENT ON ECONOMIC GROWTH: EMPIRICAL EVIDENCE

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Abstract

The development of the nonoil sector in Azerbaijan has always been one of the main goals of the Azerbaijani government. The oil sector of the economy was well developed when Azerbaijan became independent, but to use the oil source more effectively, the country was determined to diversify funds into the nonoil sector of the economy, which enhanced most industries of the economy and led to an increase in foreign direct investment. However, another source of foreign direct investment and investor attraction – stock markets – was not developed and organized properly until 1998, mainly due to outdated procedures left from USSR rule and an absence of principles, methodologies and understanding for determining how the stock market can play a major role in the expansion of the economy and the attraction of foreign investment. Currently, Azerbaijan has numerous opportunities to broaden its stock market; enable easy means of increasing the number of small businesses and startups and create opportunities for such firms to access the global economy and rapidly expand.

This research analyses the potential relationship between stock market development and economic growth to predict the possibility of a positive impact of the stock market on Azerbaijan's economic growth, overall socioeconomic welfare and business environment. For the purposes of the present research, statistical figures of the Azerbaijan's main economic indexes were collected, including gross domestic product value, foreign direct investment value, stock market liquidity and turnover values, which were then analyzed and tested at various levels of cointegration testing, Granger causality testing, vector error correction modeling, etc. All analyses were performed using Stata 11 statistical software based on 1998-2016 data.

* Baku State University, Baku, Azerbaijan, +994553155567; E-mail: tofik_aliev@hotmail.com.

The outcome of Johansen-Julius testing shows the existence of cointegration, a VECM test proves a relationship between the stock market and economic growth in the long run, and a Wald test confirms the correction of this growth in the short term by given explanatory variables. Hence, a Granger causality test is conducted and determines the bidirectional relationship between 3 variables: foreign direct investment, GDP and LIQ (stock market liquidity). From the results of the analysis, the study concludes that the expansion of the stock market and an increase in foreign direct investment will have a chain effect that leads to economic growth and improvements in social welfare in Azerbaijan.

JEL CLASSIFICATION: G00; F30.

KEYWORDS: AZERBAIJAN; STOCK MARKET; FOREIGN DIRECT INVESTMENT; GDP; JOHANSEN-JULIUS COINTEGRATION TEST; VECM MODEL; WALD TEST; GRANGER CAUSALITY TEST.

1. Introduction

Recent theoretical studies have already identified that the financial sector of a country is one of the driving forces behind its economic growth. Increasing interest in financial markets and their expansion throughout countries once more proves their importance in sustainable economic growth. Such theories have already been investigated, and a link between economic welfare and income has been found in studies conducted by Gurley and Shaw (1955, 1960, and 1967). The same approach was used by Goldsmith (1969), who found that the expansion of financial markets throughout a country leads to sustainable economic growth and welfare from research conducted on 35 countries. This evidence was then supported by the World Bank (1989), which found a strong relationship between the macroeconomic and financial indexes of the investigated countries.

In theory, a rise in GDP is strongly associated with new goods, technological evolution and revolutionary processes (Solow, 1956); as a result, an increase in GDP leads to capital allocation from areas where capital is in excess to areas where it can be used for economic and financial benefits (Levine, Loayza and Beck, 2000). Such capital allocation for the growth of

GDP is facilitated by financial intermediaries, which serve as a "bridge" between subjects of the economy of a country.

These financial intermediaries include stock markets, which have recently become one of the main indicators of the world economy. Moreover, the most severe financial crises of the 20th and 21st centuries – The Great Depression (1929) and Financial Crisis (2008) – were strongly associated and predicted through stock markets, which inevitably proves the powerful impact of the market on the macroeconomic indexes of a country, with GDP as the main indicator. Garcia and Liu (1999) concluded that through three main lines, the stock market (financial intermediaries) can be a driving force for economic growth. First, stock markets assist in the efficient allocation of capital investments by providing participants in stock markets with fair and accurate financial information, which leads to more attraction from investors and stimulates savings. Second, the attraction of investors is also achieved by providing higher yields on investments, which motivates owners of capital to refuse to keep savings out of the economy and leads to investments. The results of this process are a proper flow of investments and an optimized use of capital. Last, a higher volume of capital investments provided by financial intermediaries leads to ease of access to the finance of subjects of the economy, protecting them from bank and high interest borrowing.

Stock markets started forming in post-Soviet countries in the late 1990s as they became economically independent. However, due to being part of the USSR, which already had a specific financial infrastructure and policy without a stock market, most of these countries faced similar challenges in creating a basis for such development. Currently, CIS countries have well-developed stock markets, which can be observed from figures of the International Association of CIS Countries on stock exchanges, according to which the capitalization of markets reaches 890 billion dollars (London Stock Exchange, 2018). Hence, considering the rapid growth of their economies, CIS countries are becoming one of the strategically significant players in the global stock trade as attractive destinations for investment.

Despite Azerbaijan being one of the most developed and economically sustainable countries, its dependence on oil resources has led to the late establishment of financial institutions within the country. However, the first presence of stock market subjects can be dated to the Azerbaijan Democratic Republic, where promissory notes were issued and traded across wealthy parts of the country. However, when the country lost its independence, the issuance of local notes was banned; therefore, stock market growth temporarily

stagnated. In 1998, after the foundation of the State Committee of Securities of Azerbaijan and the registration of a full chairman in the National Depositary System, stock market activity in the Azerbaijan Republic was reestablished (SCS Azerbaijan, 2018). A year later in 1999, the Baku Stock Exchange (BSE) was established as Azerbaijan's first stock exchange with a presidential decree on "Providing the activity of the State Committee for Securities under the auspices of the President of the Azerbaijan Republic" and began its operations in September 2000 (SCS Azerbaijan, 2018).

Simultaneously, Azerbaijan began associative work with other stock markets of European countries and organizations to exchange experiences and improve infrastructure. As a result, the European Union initiated a projected on the "Development of the Stock Market in Azerbaijan," which involved legislative, technical and physical improvements to the market system of the Azerbaijan SCS (SCS Azerbaijan, 2018). Currently, the BSE has a turnover value of 13.62 billion AZN per statistics for 2017, which is 2.4 times higher than levels for 2016 (website, 2018). The total stock market has shown an increase from traded share values of $20,246 in 1998 to $8 billion, which proves that the market expands yearly and that interest in its development is becoming a priority of local government (SCS Azerbaijan, 2018).

Additionally, the government has begun using the market as support for its own borrowing. For example, in 2016, SOCAR, the main oil regulatory company of the Azerbaijan Republic, issued USD bonds valued at a total of 100 million USD for 5 years with a 5% interest rate (SOCAR Azerbaijan, 2018). This was done to obtain access to savings of the population, to assist people in earning interest and to solve internal financial issues of the company without working with different foreign debt or bank organizations. Hence, SOCAR bonds are traded locally in the BSE and give the owner not only an interest rate of 5% but also additional income with trading in the local market.

The financial market then started playing a notable role in Azerbaijan's economy while the use of the BSE started giving advantages to local companies in obtaining access to monetary funds. On the other hand, at the end of 2016, President Ilham Aliyev signed a decree endorsing "Strategic roadmaps for the national economy and main economic sectors" mainly focused on improving the nonoil sector of the economy to gain additional sources of funding. Local markets as part of alternative income can in turn be expanded and enhance the economy of the republic.

Considering the above, a relationship between stock market expansion and GDP growth may exist, which requires additional examination. Therefore, this

research analyzes causal relationships between the stock market and macroeconomic indexes of the Azerbaijan Republic based on statistical methods. As past research has only analyzed the relationship between FDI and the stock market in Azerbaijan (Aliyev, 2018) and there has been no analysis of GDP and the stock market, this work is the first to investigate this possible link between the main macroeconomic indexes and stock market performance indicators.

2. Literature Review

Over the past few decades, a number of studies have been analyzed the possible causal relationship between stock markets (or other financial intermediaries, e.g., foreign direct investment) and economic growth rates. Although the results vary, a significant number of studies show that variables of these two macroeconomic indicators have a strong causal relationship in the long term. Similar results are given by Bencivenga and Smith (1991), who prove the role of financial intermediaries in enhancing economic growth. The authors' results indicate that through financial intermediaries, it is possible to relocate savings or financial surplus into areas where there is a shortage, which increases the efficient use of capital. Another vital advantage given by stock markets is risk diversification and an increase in liquidity, which are discussed by Levine (1996) and Obstfeld (1994). The authors' results align with the common belief that intermediaries increase the proficiency of the economy by providing investors with accurate and needed data to make appropriate decisions because the role of stock markets as a primary source of information becomes more central. Reports confirming an increase in the liquidity level with accurate and timely information are provided by Greenwood and Smith (1997) and Holmstrom et al. (1998). The authors' findings are later supported by Garcia and Liu (1999), who explain the efficient role of financial markets in economic growth through three channels: by reducing the transaction cost of information, as also later supported by Paudel (2005); providing investors with higher returns to encourage them to allocate their resources and by in turn shifting capital surplus to areas where there is a shortage and thus optimizing capital allocation.

Liquidity is another advantage given by stock markets that enables the efficient allocation of capital and easy access to funding for new businesses and companies. This is found by Paudel (2005), who distinguishes stock markets as the main source of finance and assistance for firms. Several studies

on countries' macroeconomic indexes, mainly financial and economic indexes, show a correlation between them; therefore, one can always be a good predictor for another. Bahadur and Neupane (2006), in analyzing stock market fluctuations and economic indexes, found that stock markets can be used as a good predictor of growth. The major economic crashes that occurred in 1929 and 2008 were both predicted by stock market downfalls, which again proves the theory that financial intermediaries are good predictors of economic growth. Another form of liquidity is risk diversification given by stock markets, which enables investors to make a number of choices in investment channels and increases the likelihood of efficient resource allocation. Studies examining risk diversification theory confirm the existence of this linkage, which can be seen from the studies of Obstfeld (1994), Saint-Paul (1992), and Deveraux and Smith (1994). Due to ease of access to information for investors, investors are able to make appropriate investments and lower their risk of being wrong, which will eventually lead to economic growth (Stiglitz and Weiss, 1981).

Findings were further developed in the studies of Abu (2009), who used an error correction model to examine variables for 1970 to 2007 and found a positive relationship between the stock market and economic growth. The author finds a strong bidirectional relationship and concludes that an increase in stock markets can lead to economic growth in a country. A similar positive relationship was found by Dep and Mukherjee (2008), who, through a Granger causality test, found similar causality between the market and growth terms of the economy. Although most of the above studies are in line with the literature showing that the stock market has a strong impact on economic growth, we cannot diminish the effect of the banking sector (Arestis et al., 2001). Results show a notable impact of the banking sector on economic growth as well; however, results also show much more dependence than precedence. Thus, the likelihood of a bidirectional relationship is stronger than mono, which means that these two macroeconomic indexes complement each other. Robust results are also given by Shahbaz et al. (2008), who, from a Granger causality test, find a long-run relationship between the stock market and economic growth.

We conducted the first related study focused on Azerbaijan by examining the possible causal relationship between FDI and the stock market (Aliyev and Rustambeyov, 2018). The results are aligned with previous literature and show a unidirectional relationship from the stock market, which means that the expansion of stock markets may lead to FDI inflow into the country. As

FDI itself has a strong impact on economic growth in Azerbaijan by bringing additional capital into the economy, this research indirectly proves the possibility of a strong relationship between the stock market and economic growth in the country (Aliyev et al., 2018).

3. Methodology

3.1 Data

This study examines the causal relationship between the stock market and economic growth in Azerbaijan between 1998 and 2016. Data for the purpose of analysis were collected from several sources: Baku Stock Exchange, World Bank data, Azerbaijan State Statistics Committee and Azerbaijan Stock Exchange web resources. The variables chosen for further statistical and macroeconomic analysis are as follows:

- LGDP = the log of gross domestic product
- LFDI = the log of foreign direct investment into the country in USD currency
- LLIQ = the log of the total volume of traded shares in the stock market as an indicator of the liquidity level of the market
- LMT = the log of the total volume of market turnover, calculated as the total volume of shares divided by total market capitalization

Logarithms of each variable were taken to linearize the trend, which grew exponentially, easing the statistical analysis of variables with high figures (Asteriou and Price, 2007). The dataset used for the purpose of the analysis runs from 1998 to 2016, covering the period from the start of stock market establishment in Azerbaijan and to the last year for which data are available.

3.2 Model

In functional form, the analysis of the variables can be shown statistically with the formula below:

$$GDP = f(FDI, LIQ, MT)$$

The dependent variable is GDP, which is analyzed from macroeconomic indexes FDI, LIQ and MT. However, for ease of analysis and to diminish the exponential trend of the variables, logarithms of each variable were used. Stat 11 statistical software was used for the analysis of the variables.

3.3 Empirical analysis methods

Unit Root Test

In the analysis of time series data, it is essential for the variables to be cleared of time dependence and to make them stationary. If nonstationary data are used in a statistical analysis, this leads to spurious results and the data cannot be used in future forecasts (Dickey-Fuller, 1979). Hence, it is important to perform stationary tests on the variables to obtain more accurate figures, and for this purpose, augmented Dickey-Fuller or Philips-Perron tests can be used. The functional form of the unit root test is shown below:

$$\Delta y_t = \alpha + \beta_t + \lambda y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t$$

Considering that the stationarity of variables is one of the essential facets of a time series analysis, the present study starts with Augment Dickey-Fuller and Philips-Perron tests of the variables. The level of differentiation of each variable is denoted as I (d), which means the variables follow differenced "d" times to achieve stationarity. If a variable reaches stationarity without being differenced, it is denoted as I (0). Such tests are a vital facet of a time series analysis, as they prevent false results of short- and long-term cointegration analysis. The accepted lag length is calculated based on the Schwarz (SIC) and Akaike (AIC) criteria.

Cointegration Test

With the stationarity of the variables established, the analysis continues with the determination of the long-run relationships between the explanatory and dependent variables. For this purpose, the Johansen-Julius (1988) test is used, which determines the long-run relationships between variables through the estimation of trace statistics (the likelihood ratio) and statistical rank. However, to run this test, the variables must be denoted in the same order to diminish the likelihood of spurious results. Hence, the test is conducted directly after establishing the stationarity of the variables. The functional form of the test for the calculation is presented as follows:

$$Y_t = \mu + \Delta_1 Y_t - 1 + \cdots \Delta P Y_t - p + \varepsilon_t$$

The main indicators of the Johansen-Julius (1988) test are trace statistics,

also denoted as the likelihood ratio, which determines the significance level of each coefficient and the minimum number of cointegrated vectors:

$$\lambda_{trace} = -T\Sigma ln(1 - \lambda_t)$$

Another method of cointegration analysis involves determining the maximum number of eigenvalues (Hjalmarsson, 2007) as follows:

$$\lambda_{max} = -Tln(1 - \lambda_t)$$

The main purpose of trace statistics, where T is the sample size and λ is the calculated eigenvalue, is to determine the number of linear combinations that are equal to a given value. The null hypothesis for the test is an absence of cointegrated variables, against which the significance level of variables is calculated and the null hypothesis is rejected, showing the existence of at least one cointegrated variable in the equation.

Vector Error Correction Model

After having found at least one cointegrated variable, we continue with an analysis of possible short- and long-run relationships between the variables. For this purpose, we use a vector error correction model, which investigates the likelihood of relationships between variables and calculates the speed of adjustment from disequilibrium to equilibrium, which in this case is GDP. The VECM term is calculated from the formula below:

$$\Delta y_t = \delta + \delta y_{t-1} + \Sigma\Phi_i * \Delta y_{t-1} + \varepsilon_t$$

Considering the variables, the formula can be described as follows:

$$\Delta GDP_t = \delta + \rho y_{t-1} + \Sigma\Phi_i * \Delta FDI_{t-1} + \Sigma\Phi_i * \Delta LIQ_{t-1} + \Sigma\Phi_i * \Delta MT_{t-1} + \varepsilon_t$$

The main outcome of the VECM test is a statistically significant error term, which proves the existence of a long-run relationship between explanatory and dependent variables. For the investigation of the short-run relationship, a Wald test is performed where "all explanatory variables are jointly equal to zero," which is the null hypothesis for this test, while the results are calculated based on chi squared and probability values. Another index of the VECM test is the R squared term, which estimates the goodness of fit of the model and the level

at which the variables explain the model. The higher the R squared value is, the more the model fits and the variables explain it; however, in some cases, the existence of correlations between variables may also lead to a larger R squared term. Hence, the variables are tested for autocorrelation to clarify their potential existence among the variables, which can lead to spurious results.

Granger-Causality Test

Finally, to investigate the directions of the relationships of the cointegrated variables studied, the Granger causality test is conducted (Granger, 1969). This test was developed from Granger's (1969) primary function, which is used to examine the direct impact between cointegrated variables. The results are presented as the probability level of each, denoting the significance of the variables in the model based on the maximum 5% critical value. The functional equation of the test can be presented as follows:

$$x_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \; x_{t-i} + \sum_{j=1}^{m} \beta_j \; y_{t-j} + u_t \quad (1)$$

$$y_t = \alpha_0 + \sum_{i=1}^{n} \beta_i \; y_{t-i} + \sum_{j=1}^{m} \alpha \; x_{t-j} + \varepsilon_t \quad (2)$$

As shown by the formula above, to determine whether Y can Granger cause X (Formula 1), past values of X and Y should be used to predict X. In other words, if Y can Granger cause X and can be used as a predictor of X, the value of coefficient β in Equation 1 must be different from 0. Then, it can be assumed that Y can be used as a predictor and may Granger cause X. The same can be applied to Equation 2, where coefficient α must be significantly different from 0, so it can be concluded that X can Granger cause Y. Hence, if both of the coefficients are equal to 0, then no causality relationship can be found.

3.4 Estimation and results

Summary of the variables

Table 1 summarizes the values of the variables investigated.

Table 1. Summary of the values of the variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Years	19	2007.00	5.63	1998.00	2016.00
LGDP	19	24.23	0.56	23.30	24.81
LFDI	19	20.73	2.23	14.51	22.42
LLIQ	19	13.70	2.32	9.91	16.03
LMT	19	-0.88	1.35	-3.20	0.98
DLGDP	18	0.84	0.09	-0.46	0.30
DLFDI	18	0.36	1.29	-1.37	5.05
DLLIQ	18	0.31	0.71	-1.02	1.72
DLMT	18	-0.08	1.24	-3.49	1.98

The minimum value for variable "Years" equals 1998, while the maximum is 2016, supporting our goal of analyzing the relationship of the stock market to GDP within the studied time frame. The variables used in the research are described below:

LGDP – the log of gross domestic product, **LFDI** – the log of foreign direct investment into the country, **LLIQ** – the total number of traded shares in the market divided by market capitalization as an index of liquidity, and **LMT** – the log of market turnover as the total number of shares traded in the stock market.

As shown by the variables used, we initially use logs of each variable to linearize the growing exponential trend of the values. Then, to obtain stationarity, the first order of integrations of each variable is taken and denoted with the letter "D" placed at the beginning of each name. After differentiation to the first order of integration, the value of "years" decreases by 1 due to the differentiated variables for the first year being equal to "0" after subtraction. Table 1 also shows the calculated values of the mean and standard deviation for informational purposes.

Unit Root Tests

Our analysis of the relationships between variables starts with a stationarity test to eliminate the possibility of obtaining spurious results. For this purpose, two stationarity tests developed by Dickey-Fuller and Philip-Perron are used. Both test results are examined based on a 5% critical value from the given null hypothesis of "no stationarity between the variables," and if the probability levels are statistically significant, we can reject the null hypothesis and accept the alternative hypothesis of "stationarity between the variables."

As shown in Table 2, neither of the variables is stationary at the given levels, but for the first difference values, the variable become stationary at 1% and 5%, respectively. Hence, the first difference values of the variables can be used for further analysis as they reach stationarity and complement the results of other studies.

Table 2. Augmented Dickey-Fuller and Philip-Perron unit root tests

Variables	ADF				PP			
	Level		1st Difference		Level		1st Difference	
	Constant and no trend	Constant and trend	Constant and no trend	Constant and trend	Constant and no trend	Constant and trend	Constant and no trend	Constant and trend
LGDP	-1.716 (0.4229)	-0.260 (0.9904)	-3.145 (0.0234)*	-3.712 (0.0216)*	-1.643 (0.4609)	-0.369 (0.9878)	-3.152 (0.0229)*	-3.699 (0.0224)*
LFDI	-2.346 (0.1575)	-2.330 (0.4175)	-5.614 (0.00)**	-7.476 (0.00)**	-2.772 (0.0625)	-2.137 (0.5251)	-5.380 (0.00)**	-7.119 (0.00)**
LLIQ	-1.522 (0.5227)	-1.055 (0.9363)	-3.108 (0.0260)*	-3.686 (0.046)*	-1.517 (0.5252)	-1.207 (0.9090)	-3.062 (0.0295)*	-3.766 (0.045)*
LMT	-1.733 (0.4140)	-1.266 (0.8961)	-4.275 (0.00)**	-4.452 (0.0018)**	-1.764 (0.3985)	-1.285 (0.8917)	-4.283 (0.00)**	-4.501 (0.00)**

Note: * and ** show significance level of the test results, showing 5% and 1% significance level respectively. MacKinnon critical values for rejection of null hypothesis are equal to -3.75 and -4.38 for absence of trend and presence of trend respectively.

Johansen-Julius Cointegration Test

Having established stationarity among the variables, the research continues with an investigation of a possible long-run relationship between them. To test for the existence of this long-run relationship, the Johansen-Julius test is conducted using eigenvalues and maximum eigenvalues of the parameter analysis. To run this test, the maximum lag length is determined for the model based on an Akaike information criterion (AIC) and Schwartz Bayesian criterion (SBC) of equal to 2. The results of the test are shown in Table 3 below:

As shown in Table 3, the results of the an

Table 3. Johansen-Julius Cointegration Test Results (Cointegration Rank)

Hypothesis	Likelihood Ratio (Trace Statistic)	1% Critical Value	5% Critical Value
H_0 = no any cointegration among the variables	74.70**	54.46	47.21
H_0 = at most 1 cointegration among the variables	27.15	35.65	29.68
Hypothesis	**Likelihood Ratio (Max Statistic)**	**1% Critical Value**	**5% Critical Value**
H_0 = no any cointegration among the variables	47.54**	32.34	27.07
H_0 = at most 1 cointegration among the variables	18.09	25.52	20.97

Note: * and ** show significance level of the test results, showing 5% and 1% significance level respectively. Test results in cointegration outcome for 3 variables at 1% critical level.

The initial analysis of the test examines the null hypothesis of "no cointegration among the variables," which results in a significant trace statistics value (at the 1% probability level), meaning that we can reject the null hypothesis and accept the alternative hypothesis of cointegration among the variables. Furthermore, the analysis of the second null hypothesis denoting "at most 1 case of cointegration among the variables" cannot be rejected, meaning that there is 1 case of cointegration among the variables. The final results lead us to conclude that there are 3 cointegrated variables in the model in a given time frame, which supports the results of previous literature. Hence,

the variables show a long-run relationship and can be tested to determine the probability of either unidirectional or bidirectional impacts.

Vector-Error Correction Model

Finally, cointegrated variables are tested for the presence of long- or short-run relationships in a given time frame. For this purpose, the VECM model is developed based on given variables as shown in Table 4.

Table 4. VECM model for long run relationship analysis (results)

Dependent Variable: GDP		**R-squared: 0.8441 Log likelihood: 247.98 Akaike AIC= -27.33 Schwarz SC= -25.30 P>chi2= 0.0025****		
Error Correction	**Coefficient**	**Standard Error**	**Probability Level**	**z**
Cointegration Equation	-1.3980451	0.5783491	0.007**	-2.41
DLGDP (1 lag)	1.1343474	0.3720332	0.001**	3.05
DLGDP (2 lags)	-0.9274471	0.2297733	0.000**	-4.03
DLFDI (1 lag)	-1.0495501	0.0426917	0.000**	-24.58
DLFDI (2 lags)	0.9171628	0.337317	0.003**	2.71
DLLIQ (1 lag)	-1.0076869	0.2426127	0.000**	-4.15
DLLIQ (2 lags)	-0.935917	0.2398728	0.000**	-3.90
DLMT (1 lag)	-0.0031892	0.0202112	0.875	-0.16
DLMT (2 lags)	0.016682	0.0323278	0.606	0.52
Constant	0.0047279	0.0256966	0.854	0.18

Note: * and ** show significance level of the test results, showing 5% and 1% significance level respectively.

As shown by the results, the error term is negative and statistically significant at the 1% level, which follows previous literature. Moreover, a negative coefficient of the error term of -1.39 means that the variables of the model correct the disequilibrium in the short run each year by 139% toward equilibrium. Statistically significant variables for FDI and LIQ prove that both have an impact on GDP and hence may lead to growth in the long and short run. The model fit is 85%, which can be seen from the outcome of the R-squared term, while the probability level chi-squared of dependent variable GDP is statistically significant at the 1% level.

Additionally, to test the likelihood of a short-run impact of the explanatory variables, we also run a Wald test. The primary function of the Wald test is to use the null hypothesis of "all explanatory variables in the model being jointly equal to 0" and determine the impact they have in the short run on the dependent variable.

Table 5 shows that the null hypothesis can be rejected at the 1% critical value level, meaning that in the short run, the explanatory variables have an essential influence on the GDP growth level.

Table 5. Wald short run test of explanatory variables

Short Run Test Analysis of jointly impact of variables on dependent variable GDP		
1	[D_DLGDP]LD.DLFDI	equal to zero
2	[D_DLGDP]L2D.DLFDI	equal to zero
3	[D_DLGDP]LD.DLLIQ	equal to zero
4	[D_DLGDP]L2D.DLLIQ	equal to zero
5	[D_DLGDP]LD.DLMT	equal to zero
6	[D_DLGDP]L2D.DLMT	equal to zero
$chi_2(6) = 27.03$		
Probability > chi_2 = 0.001**		

Note: * and ** show significance level of the test results, showing 5% and 1% significance level respectively.

As the R-squared term is quite high, the variables must also be tested for the possibility of serial correlation, which in some cases can lead to a high R-squared term. A Durbin-Watson test of serial correlation was conducted to test for this possibility:

As shown by the results of Table 6, the probability level of the chi-squared term is greater than the lowest critical value, which means that we cannot reject the null hypothesis and that there is no serial correlation among the variables tested in the model.

Table 6. Durbin-Watson test on serial correlation

Durbin's alternative test for autocorrelation			
lags(p)	**chi-squared level**	**Degree of freedom**	**Probability > chi-squared**
3	0.093	1	0.7608
H_0: no serial correlation			

Granger Causality Test. Estimation of the impact direction of the explanatory and dependent variables.

The final step of the research applied after long- and short-run relationships between the variables are found involves determining whether the relationships are unidirectional or bidirectional. For this purpose, a Granger causality test was conducted to examine the possibility of each variable predicting another variable for the time frame and data available. The results of the test are shown in Table 7.

Table 7. Granger Causality Test Results

Null Hypothesis	Observations	F-Statistics	Probability
GDP does not granger cause FDI	19	26.68	0.000**
GDP does not granger cause LIQ	19	9.01	0.029*
GDP does not granger cause MT	19	5.3581	0.147
FDI does not granger cause GDP	19	17.52	0.001**
LIQ does not granger cause GDP	19	8.1662	0.043*
MT does not granger cause GDP	19	5.5498	0.136

Note: * and ** show significance level of the test results, showing 5% and 1% significance level respectively.

As shown for 4 cases, the F-statistics and probability level show significance, which allows us to reject the null hypothesis at 1% and 5%, respectively, and accept the alternative hypothesis that the variables "do Granger cause the others." Gross domestic product, foreign direct investment and the liquidity level of the market have bidirectional relationships in the long and short run. This result proves that the development and expansion of foreign direct investment and the stock market in Azerbaijan can lead to the growth of GDP and eventually increase the socioeconomic welfare of the country. These results are in line with previous literature and other research on the relationship between FDI and GDP in Azerbaijan (Aliyev, 2018), which can help the current government develop a stock market in Azerbaijan and draw more investors to the country. The results are also in line with President of Azerbaijan Republic policy of redirecting funds received from the oil sector toward the expansion of other sectors of the country's economy and thereby balancing economic growth with social welfare.

4. Conclusion

This study investigated the possible relationship between stock market

development and economic growth from 1998-2016 in Azerbaijan. For this purpose, relative data on FDI, stock market liquidity, stock market turnover and GDP figures were collected and analyzed. The collected data were examined with statistical tools primarily by developing a Johansen-Julius cointegration test and VECM model, which show a relationship between stock market development and economic growth in the short and long term. Data were further analyzed to determine the direction of impacts based on a Granger causality test, which found bidirectional relationships between FDI, GDP and stock market liquidity variables at statistically significant probability levels. The results of our research and the methodology used for analysis purposes follow the generally accepted trends of previous literature.

From the results of this research, we confirm the presence of a strong relationship between stock market development and economic growth in Azerbaijan from 1998-2016. Hence, for the benefit of Azerbaijan's economy, the Baku Stock Exchange must develop further plans for the expansion of the market and the attraction of foreign investors into the country through this market. For this purpose, modes of listing domestic companies in the stock market need to be extended to a larger audience, which will ultimately domestically listed companies' access to foreign funds and lead to foreign currency inflows into the economy. Moreover, the development and implementation of certain policies will be needed to guarantee the security of funds and stock market objects, which is needed to help foreign investors make investment decisions. Such actions will lead to the growth of Azerbaijan's main economic indexes, the expansion of the country's industries and improved social welfare for the Azerbaijani population.

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Sara Anwar* - Gulzar Ali†- Aasher Anwar‡

THE DEMAND AND SUPPLY SIDE ANALYSIS OF THE DETERMINANTS OF THE TEXTILE EXPORTS OF PAKISTAN

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Abstract

Exports play an imperative role, especially in the growth of emerging and developing countries. Knowing this importance, many developing countries have taken important steps to promote their textile sectors to make fruitful contributions to their growth. Textile sector exports contribute significantly to the economy of Pakistan; therefore, the present study examined the demand and supply sides of textile exports using time series data from 1985-2016. The results indicated that there are significant but negative relationships between the demand for textile exports and prices and the real effective exchange rate and the GDP of trading partners has a positive and significant relationship. Likewise, the supply of textile exports has a positive and significant relation with the relative prices and GDP of Pakistan and a negative non significant relationship with the wage rate. The study concluded that Pakistan has made headway in its textile exports, and this is even more imperative with the availability of the Generalized System of Preferences (GSP+) since 2014. Furthermore, efficient and effective strategies need to be developed to overcome the weaknesses of the Pakistani textile industry for its improvement and more fruitful contributions to the economy of Pakistan.

JEL CLASSIFICATION: A10, C40, F10, F40, F43

KEYWORDS: TEXTILE SECTOR, DEMAND SIDE ANALYSIS OF TEXTILE EXPORTS, SUPPLY SIDE ANALYSIS OF TEXTILE EXPORTS, ECONOMY OF PAKISTAN

* Institute of Development Studies, University of Agriculture Peshawar, KPK, Pakistan.
† Department of Economics, Islamia College University Peshawar, KPK, Pakistan; E-mail: gulzaricup@yahoo.com
‡ Independent Researchers.

1. Introduction

Pakistan is commonly known as an agriculture-based economy where farmers have allocated extensive areas of cultivated lands that are used to grow cotton. This enables Pakistan to establish small and large textile enterprises across the country. The textile industry is one of the oldest, largest and most commercial industries. It is the "starter" industry for countries focusing on export-oriented industrialization (Gereffi, 2002). Pakistan is the 4th largest producer of cotton and 3rd largest consumer of textile products in the world, and it ranks 8th among textile exporters. The value of textile exports in 2014-15 was $11,281.6 million. The percentage share of the textile industry with respect to the total exports of Pakistan was 55.4% in 2014-15. This sector accounted for 8% of Pakistan's the gross domestic product in 2014. Pakistan was offered the Generalized System of Preferences plus (GSP^{+}) status in 2014. It is expected that GSP^{+} will boost Pakistani exports (Pakistan Economic Survey, 2014).

In Pakistan, the share of the textile sector is approximately 46 percent in the output of the manufacturing sector, and earnings from exports account for approximately 60 percent. The textile sector contributes approximately one-fourth of Pakistan's industrial value. The sector uses approximately 40 percent of the banking credit offered to the manufacturing sector. The reason for focusing on the textile sector is that its contribution to exports is more than 50 percent and the sector is considered the backbone of the economy. This is the dominant sector of the entire manufacturing sector of Pakistan. This sector plays an important role in total exports, employment, exchange earnings, and investment. During the MFA regime, there were quantitative restrictions in the form of quotas later on that were eased by the ATC in 2005. Pakistan has made progress but not up to the levels of other developing countries. This study is important for investors and policy makers to understand the reasons for the slow growth of textile product exports.

The main activity of Pakistan's textile sector is spinning activity that manufacturers good quality yarn. Yarn is the major textile product that Pakistan exports. Various areas such as the spinning and weaving industry are components of the textile industry and are composed of small and medium enterprises. The sector is facing problems such as asymmetric strategies, energy crises, the war on terror, inflation, cotton shortages, decreased foreign direct investment, technological lags and the global economic crisis. The war

against terrorism results in monstrous infrastructure devastation, and natural disasters are additional problems for Pakistan's textile sector (Siddiqi et al., 2012). However, there is more demand for more value-added finished textile products such as garments, towels, etc. Pakistan's admirable yarn is exported in place of high priced products such as garments or fabric. South Korea, Hong Kong and Japan are heavy importers of good-quality yarn. Their textile industries are flourishing by transforming yarn to value-added products to obtain better values.

Developed countries imposed quotas and other trade restricting measures on the imports of textiles products from developing countries under the Multifiber Agreement (MFA, 1974-94). Its motive was to protect the textile industries of developed countries through the imposition of quotas, restricted either bilateral agreement or unilateral action. The main buyers of the textile exports of Pakistan were mainly the countries of the European Union and the United States who imposed quota restrictions under this agreement, leading to adverse effects on the textile exports of Pakistan and those of some other developing countries (SMEDA, 2005). Under the Multifiber Agreement, export restrictions were imposed on many countries including Pakistan (Spinanger, 1999).

Due to these restrictions, some of the internal problems faced by the economy of Pakistan severely affect the textile sector of Pakistan. These internal factors mainly affect the supply side whereas national and international restrictions on the textile sector have adverse effects on the demand side of textile exports, production and contributions. Most of the studies have only analyzed the demand side determinants of textile exports. This research will study both the demand and supply of the textile industry because both sides have their own effects on textile exports. This study will focus on the determinants of the demand and supply sides that affect the textile exports of Pakistan. In addition, the present research will also highlight the effects of MFA removal on the textiles exported from Pakistan.

1.1 Objectives of the Study

The present study has the following main objectives.

i. To find the long-run relationship between the demand- and supply-side determinants and the textile exports of Pakistan.
ii. To examine the effects of MFA removal on the exports of the textile industry of Pakistan.

iii. To suggest policy measures for improving the performance of the textile sector.

2. Literature Review

The exports of the textile sector play an important role in enhancing economic growth in developing countries, especially agrarian-dependent countries; and the textile sector is referred to as the "engine of growth". The prosperity and welfare of a country depends on its growth and productivity. Many developing countries are agriculture-based economics. Exports from these countries are concentrated in a few agricultural-based products. Pakistan, where textiles and rice are the major exporting commodities, is no exception to this rule. The textile industry plays a paramount role in the economic development of countries such as Pakistan (Rabia and Attiya, 2013). Malik (2000) examined the factors of the textile and clothing exports of Pakistan using a sample covering 40 years from 1960-2000. Cointegration analysis was conducted to analyze of the demand side and supply side export equations. The study showed that the coefficients of the price of textile exports and world income were insignificant whereas the variables on the supply side were found to be more powerful.

Subhani et al. (2007) examined the improvement in the export performance of the textile sector of Pakistan. The study used the correlation between the independent variables with three years of primary data from 2005-2007, which were collected from the textile exporters of Pakistan, along with secondary data to analyze the improved export performance of companies and the effects of the determinants on export performance. The study revealed that past export performance satisfaction is the only important determinant of the export performance of textile exporters of Pakistan.

Hussain (2010) investigated the demand determinants of the export performance of Pakistan at the three-digit Standard International Trade Classification (SITC) level. With the aim of estimating long-run elasticity of exports at the disaggregated level, the study used the generalized method of moments (GMM) with annual data from 1988 to 2009. The study revealed that world demand is the major factor in determining the exports of Pakistan at the disaggregated level. Most of the exports were receptive to international demand and relative prices. The level of this receptiveness was higher for the exports of value added products than for the exports of low value added

products. The study suggested that Pakistan should diversify its exports from low to high value added products and considered this to be the best strategy to attain benefits from increased international demand.

Zada (2010) examined the elements of exports of Pakistan by using data from 1975-2008. First, the researcher employed the Generalized Methods of Moments (GMM) and then the empirical Bayesian technique to compare and obtain consistent estimates. The study revealed that interest in exports was greater for the countries in NAFTA, the European Union and the Middle East region. The exports of Pakistan are sensitive and affected by the diversity in demand and prices, and demand side factors were more powerful. The consequence of the income elasticities was greater demand for exports, and the price elasticity of the demand for exports was small but had important consequences for all economies. The study strongly rejected the compression strategy of imports, which affected export production and the production of the import substitutes.

Siddiqi et al. (2012) examined the factors of the demand for textile and garment exports for Pakistan. The cointegration approach was applied to assess the long-term relationship between the demand for exports and their factors for the 19711-2009 period. This paper examines annual data from the 1971 to 2009 period. The study used the methodology of the probability of maximum cointegration. The study found that world income is the largest determinant of the demand for exports, and trade opening is the second largest determinant of the demand for exports. The study suggested that Pakistani producers should adopt a strategy based on the market demand; and despite the increased prices of textiles, it is still affordable for importers. Therefore, Pakistan should produce value-added value products such as clothing and fabrics instead of export-oriented quality yarn.

Aleena and Zafar (2014) examined the impacts of trade reform policies for South Asian countries such as Pakistan, Sri Lanka, Bangladesh, and India; and the panel data technique was used for the period of 1984-2012. FMOLS estimation showed that the traditional factors of the imperfect substitute model such as relative prices, productive capacity, and variable cost have significant impacts on the export supply performance of South Asian nations. The researchers extended the traditional imperfect substitute model by including trade openness, corruption, energy, and technological compression, which also have significant impacts on export supply performance.

Ahmed (2014) examined the effect of removing quotas on the exports of the textile and attire sectors of Pakistan for 31 years from 1980 to 2011. The study revealed a long-run equilibrium among the variables by using the cointegration technique based on a finite vector autoregressive model. The study revealed that Pakistan has a low comparative advantage in the clothing sector, but in the textile sector, Pakistan has a greater comparative advantage. Therefore, the impact of the clothing sector on exports is positive but weaker and nonsignificant, but the textile sector has a powerful influence on textile exports compared to the clothing sector. Both have the correct and positive signs. The results also showed that removing quotas did not enhance export performance as the quota removal dummy showed no significant impact on exports. The study suggested that attention should be given to value added products instead of cotton products to compete in the world market because the comparative advantage of Pakistan in the clothing sector is weaker and thus does not play a significant role. Thus, importance should be given to garments and hosiery products by policy makers.

3. Methodology of the Study

3.1 Empirical Model of the Study

The traditional way to evaluate the demand and supply side factors of exports is the "imperfect substitute model" based on the assumption that neither exports nor imports are perfect substitutes for the domestic goods in a country (Goldstein and Khan, 1978). The demand for exports is specified to be a function of the model that depends on the economic condition of the trading partners, real effective exchange rate, and the prices of exports and prices of competing goods in the world market. Furthermore, the supply side of exports depends on the production capacity and relative prices. In the present study, the same approach is used with some additional variables added to the models.

To evaluate the demand side of Pakistani textile exports, the following model is used. It follows the models of (Lundborg, 1981; Abbott, Vita, 2002) used in their studies.

$$LnY^{D}_{t} = \alpha_0 + \alpha_1 \ \ lnREER_t + \alpha_2 lnWY_t + \alpha_3 lnPX_t + \alpha_4 D_1 + u_i \qquad (1)$$

where "Y^D" is demand for textile exports, "REER" represents the real effective exchange rate, "WY" is the GDP of a trading partner, "PX" is the price of exports and "D1" is the dummy variable for cancelling the effect of removal of MFA. u_i is the stochastic error term in the model.

Regarding the supply side of textile exports, the idea was taken from the studies of (Virmani, 1991; and Hassan and Khan, 1994), and the following model is used in the study.

$$Ln\ Y^s_t = \beta_0 + \beta_1 lnW_t + \beta_2 lnY_t + \beta_3 ln\ RP_t + \beta_4 D2 + u_i \quad (2)$$

In the above econometric model, "Y^s" represents the supply side of textile exports, "W" is the wage rate, "Y" is the GDP of Pakistan, "RP" is the relative price of exports and "D2" is the dummy variable.

3.2 Specification of Models

As few of the variables were stationary at levels and few were on the first difference, the autoregressive distributive model will be used for the study.

3.2.1 Demand Side Model

The demand side model for textile exports in ARDL form and the error correction model are given below. For the demand side, the specifications that are applied for regression analysis are as follows:

$$LnY_t^D = \propto_0 + \sum_{i=1}^{n} \propto_{1i} \Delta LnY_{t-i}^D \quad \sum_{i=0}^{n} \propto_{2i} \Delta LnReer_{t-i} + \sum_{i=0}^{n} \propto_{3i} \Delta LnWY_{t-i} + \sum_{i=0}^{n} \propto_{4i} \Delta LnPX_{t-i} + \sum_{i=0}^{n} \propto_{5i} \Delta D1_{t-i} + \beta_1 LnY_{t-i}^D + \beta_2 Ln\ Reer_{t-i} + \beta_3 Ln\ WY_{t-i} + \beta_4 LnPX_{t-i} + \beta_5 Ln\ D1_{t-i} + e_t$$

where "Δ" denotes the first difference operator and "e_t" is the usual white noise residuals.

$$\Delta LnY_t^D = \propto_0 + \sum_{i=1}^{n} \propto_{1i} \Delta LnY_{t-i}^D + \sum_{i=0}^{n} \propto_{2i} \Delta LnReer_{t-i} + \sum_{i=0}^{n} \propto_{3i} \Delta LnWY_{t-i} + \sum_{i=0}^{n} \propto_{4i} \Delta LnPX_{t-i} + \sum_{i=0}^{n} \propto_{5i} \Delta D1_{t-i} + \lambda ECT_{t-i} + u_t$$

where "λ" is the speed of the adjustment parameter toward long-run equilibrium.

3.2.2 Supply Side Model

The supply side model for textile export in ARDL form and the error correction model are given below.

$$\Delta LnY_t^s = \propto_0 + \sum_{i=1}^{n} \propto_{1i} \Delta LnY_{t-i}^s + \sum_{i=0}^{n} \propto_{2i} \Delta LnW_{t-i} + \sum_{i=0}^{n} \propto_{3i} \Delta LnY_{t-i} + \sum_{i=0}^{n} \propto_{4i} \Delta LnRP_{t-i} + \sum_{i=0}^{n} \propto_{5i} \Delta D2_{t-i} + \beta_1 LnY_{t-i}^s + \beta_2 Ln\, W_{t-i} + \beta_3 Ln\, Y_{t-i} + \beta_4 LnRP_{t-i} + \beta_5 Ln\, D2_{t-i} + e_t$$

where "Δ" denotes the first difference operator and "e_t" is the usual white noise residuals.

$$L\Delta nY_t^s = + \sum_{i=1}^{n} \propto_{1i} \Delta LnY_{t-i}^s + \sum_{i=0}^{n} \propto_{2i} \Delta LnW_{t-i} + \sum_{i=0}^{n} \propto_{3i} \Delta LnY_{t-i} + \sum_{i=0}^{n} \propto_{4i} \Delta LnRP_{t-i} + \sum_{i=0}^{n} \propto_{5i} \Delta D2_{t-i} + \lambda ECT_{t-1} + u_t$$

where "λ" is the speed of the adjustment parameter toward the long-run equilibrium.

3.3 Rationale for Selection of Variables

The variables are selected for the present study to empirically examine the demand and supply side determinants of the textile exports of Pakistan after deeply analyzing the past literature. There were many variables that were used by many researchers; however, after keenly observing the relationships and behaviors, the following variables that were most suitable to apply were selected and used in the present study.

Table 1. Justifications of the Variables

Variables	acronyms	Expected sign/relationship	References
Real effective exchange rate	REER	Negative	Ahmed (2000), Ahmed (2014) and Aftab and Aurangzeb (2002) examined the behavior of exports and found that devalued currency increases the competitiveness of exports.
World income	WY	Positive	Afzal (2006) and Rijesh (2007) found a significant and positive relationship between world income and India's machine tool export demand.
Price of export	PX	Negative	Malik (2000) reported a negative effect of export prices on the demand for textile exports.
Wages	W	Negative	Barros and Amazonas (1996) found a negative and significant effect of a change in real wages on Brazilian manufacturing exports.
GDP of Pakistan	Y	Positive	Virmani (1991) found a significant and positive relation between GDP and the export supply of manufactured products for India.
Relative price	RP	Positive	Atique and Ahmed (2003) reported that if the price of an export is higher than the domestic price, it will encourage manufacturers to increase the textile exports of Pakistan.

3.4 Data and data sources

The present research will focus on the determinants of the exports of the textile industry of Pakistan. The demand side and supply side determinants are regressed and examined separately. Furthermore, the research also covers the effect of MFA removal. The data are taken from different sources, such as the All Pakistan Textile and Mills and Association (APTMA), the Economic

Survey of Pakistan, the World Trade Organization (WTO), the World Development Indicators (WDI) and the International Labor Organization (ILO).

4. Analysis, Results and Discussions

4.1 Unit Root test

A unit root test is vital in observing the stationarity of time series data. The test is important to estimate whether the variables observed have a tendency to return to the long-term trend following a shock (stationery) or whether the variables follow a random walk containing a unit root. If the variables follow a random walk after a temporary or permanent shock, the regression between variables is spurious. In order to avoid spurious regression outcomes, a unit root test was performed. A unit root test was conducted to test the stationarity of the data and to verify the integration order, which means determining whether the variables are stationary at levels or 1^{st} differences. The most frequently used Augmented Dickey Fuller (ADF) test is utilized to test the stationarity of the variables. It is essential to know the level of stationarity, especially when determining the techniques suitable for the analysis. As most economic time series are nonstationary and regression analysis provides spurious and unreliable estimates, first, there is a need to make the series stationary in the same order. If the series are not integrated at the same level, then it is justified to use the Autoregressive Distributive Model (ARDL) methodology for long-run estimation. The outcome of the ADF test is applied to the model.

Table 2. Augmented Dickey-Fuller unit root Test Results

Variables	Acronyms	Levels	1st Difference (p-values)	Order of integration
Demand for textile exports	LnY^D_t	0.5822	0.0020	I(1)
Real effective exchange rate	$lnREER_t$	0.0457	…….	I(0)
World income	$lnWY_t$	0.8667	0.0344	I(1)
Price of exports	$lnPX_t$	0.0667	0.0211	I(1)
Supply of textile exports	LnY^S_t	0.5822	0.0020	I(1)
Wage rate	LnW_t	0.8044	0.0177	I(1)
GDP of Pakistan	lnY_t	0.1864	0.0234	I(1)
Relative price of textile exports	$LnRP_t$	0.0453	…….	I(0)
Dummy 1	D1	0.6144	0.0010	I(1)
Dummy 2	D2	0.6144	0.0010	I(1)

The probability value of the first variable, demand for textile exports, is 58%, which shows that the data are nonstationary at different levels. Therefore, in order to make the data stationary, we have taken the 1st difference as mentioned in the above table so that the demand for textile exports is stationary at the 1st difference. The second variable, the real effective exchange rate, has a probability of 4 percent, which shows that the data are stationary at levels. The probability of the third variable, income of the trading partner, is 86 percent, which means that the data are not stationary. To make the data stationary, the 1st difference was taken. The probability value of the price of exports is also 6 percent, which shows that the data are nonstationary; therefore, the 1st difference is needed to make the data stationary. The probability of supplying textile exports is 58 percent, which is higher than 5 percent; thus, the data are not stationary, and the 1st difference was taken in order to make the data stationary. The p-values of the real wages and GDP of Pakistan also show that the data of these variables are not stationary, so the 1st difference is needed in order to make the data stationary. Furthermore, the relative price is stationary at the 4 percent level, which is less than 5 percent.

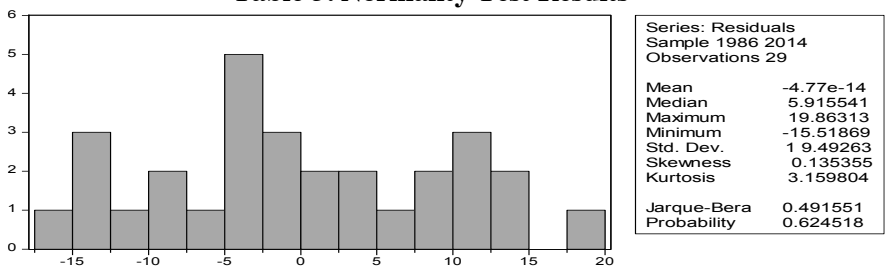
4.2 Estimation of the Demand Side Textile Exports model

4.2.1 Normality test

The ordinary least squares assumes that the residuals are normally distributed. The normality of the error term is checked by the Jarque-Bera test.

$$\text{Jarque-Bera} = \frac{n-k+1}{6}\left(s^2 \frac{1}{4}(kt-3)\right)$$

Table 3. Normality Test Results



The Jarque-Bera test of normality is a large sample test. It is also based on the OLS residuals. This test first assesses the skewness and kurtosis. The results of the Jarque-Bera test shows that the Jarque-Bera statistic is approximately 0.491551, and the probability of obtaining such a statistic under the normality assumption is approximately 0.624518, which is greater than 5%. Therefore, we accept the null hypothesis, and the null hypothesis is that the error term of the model is normally distributed.

4.2.2 VAR Lag-Length Criteria

The major issue of the application of the ARDL is the selection of the proper lag order of the distribution to analyze the data over the long run. After determining the order of integration, optimal lag length selection is performed for variables. The lag length criterion is very useful to analyze the time series data in order to decide the lags to use in the data.

Table 4. VAR Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	52.96733	NA	3.56e-07	-3.497666	-3.307351	-3.439485
1	200.7667	242.8133	2.95e-11	-12.91191	-11.96034*	-12.62100
2	223.4938	30.84383*	1.97e-11*	-13.39241*	-11.67958	-12.86878*

* indicates lag order selected by the criterion

The maximum lag was 2 for the study based on the results of the LR (sequential modified LR test statistic (each test at the 5% level)), FPE (final prediction error) and AIC (Akaike information criterion)

4.2.3 Regression Analysis of the Demand Side Textile Exports Model

If the model includes one or more lagged dependent variables among its explanatory variables, this model is known as the autoregressive distributed lag model. The Autoregressive Distributed Lag (ARDL) method developed by (Pesaran et al., 2001) was used to establish cointegration relationships among the variables. In addition, it can use to overcome the stationary problem in time-series regression. The advantage of the ARDL method is that it can be applied to the model regardless of whether the independent variables are stationary at I(0) or I(1). The dependent variable must be stationary at I(1). As a result, a dynamic model known as the Autoregressive Distributed lag model (ARDL) will be estimated and the results are as follows.

Table 5. ARDL Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	20.871580	10.77950	1.936229	0.0178
D(LNPX(-1))	-0.153742	0.058143	2.644207	0.0039
D(LNPX(-2))	-0.145731	0.062416	2.334838	0.0208
D(LNREER(-1))	-0.357387	0.127972	2.792704	0.0444
D(LNREER(-2))	-0.203177	0.096951	2.095669	0.0102
D(WY(-1))	0.921994	0.454387	2.029095	0.0244
D(WY(-2))	0.972778	0.340358	2.858105	0.0401
D1	0.003537	0.027377	0.129212	0.0399
ECT(-1)	-0.381992	0.254663	-1.499990	0.0144
R-squared	0.854410	Durbin-Watson stat		2.401382
Adjusted R-squared	0.835878	Prob (F-statistic)		0.000027

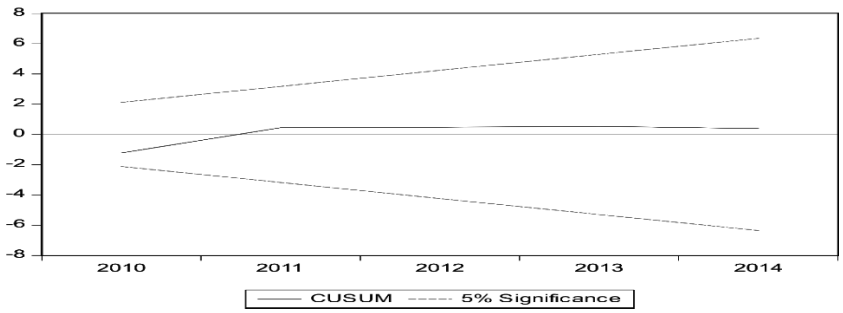
The price of exports has a negative relationship (-0.153742) with the demand for textile exports, but the effect is significant. REER also has a negative relationship (-0.357387) with the dependent variable demand for textile exports and is significant (0.0444). World income has a positive relationship (0.921994) with the demand for textile exports and has a significant (0.0244) effect. The dummy has a positive relationship (0.003537) and is significant (0.0399). The coefficient of error correction term (ECT) of the model is negative and significant. Therefore, we can conclude that the entire system can return to the long-run equilibrium at a speed of adjustment of 38%. Moreover, the adjusted R-squared is 0.835878 or 83 percent, which represents a good fit; and the f statistic is 0.000027, which means that the model is overall good.

4.2.4 Stability Analysis of the Demand Side Textile Exports Model

A graphical representation of the CUSUM for the long-run ARDL model is shown in the figure. According to (Bahmani and Oskooee, 2004), the null

hypothesis (i.e., the regression equation is correctly specified) cannot be rejected if the plot of these statistics remains within the critical bounds of the 5% significance level.

Figure 1. of the CUSUM test for ARDL model 1.



Here, in this figure, the blue line is inside the two red lines. The middle line represents our data as the CUSUM line, and the two outer lines are the 5% significance level. As the CUSUM line lies within the two critical lines, it means that the data of the model are perfectly stable or there is no instability in the data.

As the probability (0.1057) is greater than 5%, we accept the null hypothesis. The null hypothesis is that there is no serial correlation in the error term of this model. The probability value is 0.1057, which is more than 0.05, so it is concluded that there is no serial correlation. The results are given below in the table.

Table 6. Breusch-Godfrey Serial Correlation LM Test

F-statistic	2.000836	Prob. F(2,9)	0.1910
Obs*R-squared	8.310095	Prob. Chi-Squared(2)	0.1057

The models were also checked for heteroscedasticity by applying the Breusch-Pagan-Godfrey test; and as the probability (0.1057) was greater than 5% or 0.05, we accepted the null hypothesis. The null hypothesis is that there is no serial correlation.

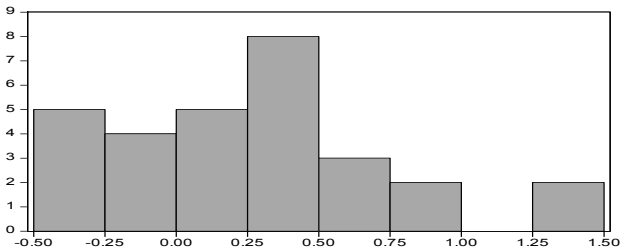
4.3 Estimation of the Supply Side Textile Exports Model

4.3.1 Normality test

One assumption of the OLS is that the residual is normally distributed. The normality of the error term is checked by the Jarque-Bera test.

$$\text{Jarque-Bera} = \frac{n-k+1}{6}\left(s^2 \frac{1}{4}(kt-3)\right)$$

Figure 2. Normality Test Results



Since probability (0.355227) is greater than 5%, we accept the null hypothesis. The null hypothesis is that the residual of the model is normally distributed.

4.3.2 VAR Lag Order Selection Criteria

The lag length criterion is very useful to analyze the time series data in order to determine the lags to use in the data.

Table 7. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	60.13926	NA	2.13e-07	-4.009947	-3.819632	-3.951766
1	156.2489	157.8944*	7.08e-10*	-9.732064*	-8.780489*	-9.441158*
2	167.1635	14.81264	1.10e-09	-9.368819	-7.655985	-8.845188

* indicates lag order selected by the criterion

Here, the maximum lag for the study would be 1 according to the results. LR: sequential modified LR test statistic (each test at the 5% level), FPE: final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, and HQ: Hannan-Quinn information criterion.

4.3.3 Regression Analysis of the Supply Side Textile Exports Model

After regressing the determinants of the demand side, the supply side model is regressed to examine the effects of its determinants on the textile exports of Pakistan. For that purpose, first, the lag length criteria were analyzed to select the appropriate length of the ARDL lag. The results of the regression analysis of the ARDL are given in table 8 below.

Table 8. Regression Analysis of the Supply Side Textile Exports Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.012751	0.008141	2.566219	0.0136
D(LNW(-1))	-0.061701	0.024628	2.505333	0.0151
D(LNW(-2))	-0.049263	0.024729	1.992118	0.0214
D(LNRP(-1))	0.176260	0.099533	1.770870	0.0956
D(LNRP(-2))	0.162653	0.084530	1.924212	0.0369
D(LNY(-1))	0.611309	0.294230	2.077659	0.0139
D(LNY(-2))	0.796542	0.318928	2.497562	0.0425
D2	0.054438	0.024048	2.263737	0.0279
ECT(-1)	-0.656158	0.237066	-2.767829	0.0144

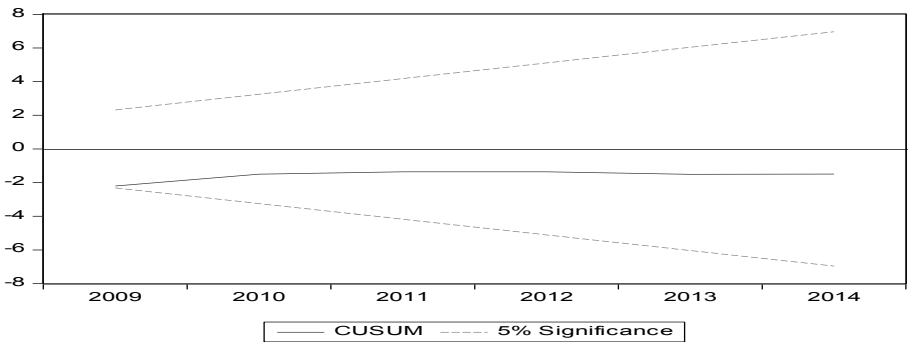
R-squared	0.8254041	Durbin-Watson stat	2.302312
Adjusted R-squared	0.8584782	Prob(F-statistic)	0.000821

The regression results show that the supply of textile exports and wages has a negative relationship (-0.061701) that is significant as the probability is less than 0.05, that is, 0.0151. Moreover, the relative price has an nonsignificant

(0.0956) but positive relationship (0.176260) with the supply of textile exports. Similarly, the income of Pakistan also has a significant (0.0139) and positive relationship (0.611309) with the dependent variable of the supply of textile exports. Furthermore, Dummy 2 is significant (0.0279) and has a positive association (0.054438) with the supply of textile exports. The coefficient of the error correction term (ECT) of the model is negative (-0.656158) and is significant (0.0144). Therefore, we can conclude that the entire system can return to the long-run equilibrium at speed of adjustment of 65%. Moreover, an adjusted R-squared of (0.8254041) represents 82 percent, which is a good fit; and the f statistic of (0.000821) means that the model is overall good.

4.3.4 Stability Analysis of the Supply Side Textile Exports Model

Figure 3. of the CUSUM test



Here, in this figure, the middle line represents our data as the CUSUM line, and the two outer lines are the 5% significance level. As the CUSUM line lies within the two critical lines, it means that the data of the model are perfectly stable or there is no instability in the data.

Table 9. Breusch-Godfrey Serial Correlation LM Test

F-statistic	2.040821	Prob. F(2,9)	0.2310
Obs*R-squared	8.218025	Prob. Chi-Squared(2)	0.2002

The models were also checked for heteroscedasticity by applying the Breusch-Pagan-Godfrey test; and as the probability (0.2310) was greater than 5% or 0.05, we accepted the null hypothesis. Null hypothesis is that there is no serial correlation.

5. Conclusion

This study sought to find the impacts of the determinants of the textile exports of Pakistan, which include both the demand and supply sides. Log linear form models were constructed to achieve the objective. Several macroeconomic variables were used to conduct the study; and the data for these variables were taken from different sources such as the World Trade Organization, the World Development Indicators, the International Labor Organization, and the Economic Survey of Pakistan. The ARDL approach was applied. The results show that the demand for textile exports had a positive and significant relationship with export prices and with the GDP of the trading partner, the demand for textile exports has a negative and significant relationship with the real effective exchange rate while, and dummy 1 has a positive but nonsignificant relationship. However, the supply of textile exports has a positive and significant relationship with the relative price of exports and with the GDP of Pakistan, it has a negative and significant relationship with Dummy 2, and it has a positive but insignificant relationship with the wage rate. The second objective was to determine the effect of MFA removal. The MFA was an agreement based on the restrictions imposed by importing countries on exporters to protect their local industries. The removal of the MFA brought a positive change in the export of textiles from Pakistan but not up to the desired level. Even in the quota regime, Pakistan did not fulfill its quota due to insufficient production. Now, in the quota-free regime, Pakistan is still unable to compete with its competitors due to the current situation, and the government should take notice of the causes and problems and how they can be overcome.

6. Recommendations

The main recommendations based on the study's findings are as follows.

- The results of the study revealed that the price and demand for textile exports have a negative relationship with each other; therefore, policy makers should take this relationship seriously when determining the price of textile exports.
- The study also revealed that the demand for textiles has a negative but significant relationship with the real effective exchange rate, which means that if currency devaluation occurs, the demand for textile exports will increase. The government should pay attention to maintaining the stability of the value of its currency.
- Another important result is that the supply of textile exports and the GDP of Pakistan have a positive and significant relationships with each other. Therefore, authorities should develop strategies that can strengthen the GDP of Pakistan. This will increase the capability of textile production and exports.
- As the MFA restrictions have been removed now, it is the time to benefit from this. Moreover, Pakistan has also gained GPS+ status, and Pakistan can make remarkable progress by showing excellent performance in textile exports as Pakistan will not have this status forever. Therefore, decision makers must develop possible strategies in this regard that will provide long-term benefits.

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