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Labor cost and Export Dynamics in a Developing Economy: The impact of minimum wage increase on trade margins in Peru

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This research investigates the impact of minimum wage increases on the export performance of firms in Peru. The study explores how varying degrees of exposure to minimum wage hikes, defined by departmental and industry-level classifications, influence key export outcomes such as the propensity to export, export values, the number of markets, and the number of products exported. Utilizing a firm level administrative data, this research employs a difference-in-differences methodology, concluding that firms with higher exposure to minimum wage increases exhibit a significant reduction in their likelihood to engage in export activities. This negative impact is particularly pronounced in formal sectors, where firms are more strictly bound by wage regulations, thereby facing higher labor costs that diminish their international competitiveness. The results include robustness checks, such as placebo and falsification tests, and an event study analysis, to validate the main findings by demonstrating that the negative effects on export propensity and values are indeed a consequence of the 2016 minimum wage hike.

JEL Classification: F60, F14.

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I. INTRODUCTION

During the last three decades, economic literature has emphasized the crucial role of international trade for developing economics, due to it represent gains in income, technological progress and welfare (Bernard et al.,2007; Engelbrecht, 1997). However, while various developing economies have implemented public policies aimed at enhancing export performance by reducing costs for enterprises, there remains a significant gap in understanding how different types of public policies might impact export outcomes within the country.

In that sense, the objective of this study is examined how one of the main instruments of labor policy such a minimum wage could affect the international competitiveness of firms in a developing country. According to the theoretical perspective, the main objective behind setting a minimum wage is to reduce poverty through redistributive mechanisms by giving an upper income to unskilled workers. However, changes in minimum wages could have a secondary effect by adding rigidities to the labor market (Inter-American Development Bank, 2017).

Under the debate of these two approaches, the main goal of this research is evaluating if an expansion of minimum wages could affect the export performance through an increase of labor cost, which influence the capacity of investment of firms (Ni et al.,2020). Likewise, focusing in a developing economy, it will be crucial to evaluate the role of informality under this mechanism, considering the possibility that this externality could help to mitigate the effects variations in labor cost of firms and its impact on export dynamics.

In particular, the main research question will be how labor costs, such as an increase in the minimum wage, could affect the performance of large Peruvian firms in international markets. In addition, how firms react to movements of labor policy in high informality environments.

Consequently, the main hypothesis is that high exposure firms to fluctuations of minimum wage are susceptible to being negative affected by an increase of this type in labor cost. In addition, taking on account the local environment, a complementary hypothesis to test will be that high informality environment could help to exporters to maintain same level of competitiveness in international markets by mitigating this increased in labor cost.

The primary motivation for exploring this topic lies in the necessity for developing countries, especially those in Latin America, to comprehend the broader impacts of raising the minimum wage on various economic sectors, considering one of the main characteristics of their labor markets such a high rate of informality. This research aims to bridge the existing knowledge gap by investigating the spillover effects of this labor policy on export dynamics of a developing economy such a Peru[1]. Consequently, the findings will enable policymakers to consider the wider implications of such policies on different economic actors and stakeholders.

Another strong reason to study this relation between labor cost and export performance is that Peru experienced a significant debate between business associations and civil groups over a proposed reduction in labor costs[2] in 2015, specifically through the reduction of social benefits in the private sector. Large exporters contended that lowering labor costs would enhance international competitiveness. However, this proposal sparked widespread social protests across the country, leading to its eventual abandonment. This research aims to elucidate the relationship between labor costs and export performance, providing insights that are particularly relevant in the context of such contentious policy discussions.

In addition, there is an interesting debate in the economic literature about the impacts of minimum wage and export performance. Empirical literature often aligns with economic

[1] In 2016, the informality rate in Peru was around 72.1% (INEI,2017)
[2] Law No. 30288 – "Law that promotes access of young people to the labor market and social protection", approved in December 2014.

theory, suggesting that increases in the minimum wage negatively impact export outcomes (Gan et al., 2016; Akgündüz et al., 2019). However, contrary evidence also exists, indicating a potential positive relationship between labor costs and exporting. This suggests that rising labor costs may be offset by increased labor demand in a dynamic economy (Ni et al., 2020; Nguyen, 2021). Moreover, this research will be the first one to analyse the relationship between minimum wage, informality and export competitiveness in Latin American, where characteristics such as informality or productive structure become attractive in the potential results.

To address these questions, this research utilizes administrative data on Peruvian firms and their export activities at the firm level from 2014 to 2016. By adopting a local market approach, it examines the heterogeneity of exposure levels not only geographically but also across different economic sectors. This dataset allows to design the increase of minimum wage in 2016 like a natural experiment to evaluate its effects on various trade margin outcomes.

This study will be pioneering in its use of firm-level administrative data to examine the impact of labor policy on exports in Peru. Additionally, it uniquely analyses both extensive and intensive trade margins, incorporating different specifications to assess the sensitivity of Peruvian firms to changes in labor costs and considering informality environment.

The findings of this study reveal a significant negative impact of minimum wage exposure on various export-related outcomes. Specifically, firms with higher exposure to minimum wage increases, whether measured by departmental or industry-specific (CIIU) exposure, experienced a marked decline in their propensity to export, the value of their exports, and the diversity of export markets and products. These results emphasize the vulnerability of export performance to labor cost increases, particularly in more formalized regions where labor market adjustments are less flexible. The study's robustness checks, including placebo and

falsification tests, further validate these findings, while the event study analysis demonstrates that the negative effects on export activities intensified following the policy implementation, underscoring the causal relationship between minimum wage hikes and reduced export performance.

The remainder of this research is organized as follows. The second section will provide relevant theoretical and empirical evidence related to minimum wage and international trade. Next, the data description section presents the main details of the datasets used. Then, the fourth section focuses on exhibiting the methodical strategy to estimate the causal effect. The results section will show the main findings of the principal equations and previous analysis. After that, the mechanism section will describe the main causal relationship between labor cost and export dynamics. Finally, some crucial conclusions and their pertinence with public policy must be highlighted.

II. LITERATURE REVIEW

This section will describe the main theoretical models that examine the relationship between minimum wage and export performance. Additionally, presenting empirical evidence will allow to understand different effects and several methodologies that can influence these findings.

It is relevant to begging with one of the most cited theorical works that study the relationship between international trade and minimum wage. Brecher (1974) argues that there is a reduction in the exports of products when the minimum wage is increased for some labour-intensive countries, and how particular characteristics of each economy could influence this final effects. Considering a dynamic environment, Flug and Galor (1986) show that the minimum wage for unskilled workers in a small economy that produces both goods (skill-intensive and un-intensive) and exports the skill-intensive one will increase the trade volume. Another relevant

theorical work in this field was made by Davis (1998), where setting a country with a minimum-wage system, this binding wage system will determine goods price, the employment ratio, and the unemployment level, highlighting the relevance of the labor market fluctuations could influence tradable sector dynamics in the economy.

Under this framework, a rise in minimum wage could affect export performance through shocks of productivity and cost movements, according to Melitz (2003). In this primary model, with monopolistic competition, heterogeneous firms and constant marginal costs, the agents face fixed and variable costs to export. The primary preposition of the model is that only firms with high productivity can generate enough profit to face this cost to export. In that case, these firms can insert in the international market and generate profit, while medium firms can sell in the local market, and other firms with low productivity must shut down from the market. Complementing the previous model, Bernard et al. (2007) gives some conclusions about the crucial role of cost in exporting behaviour. The authors determine that expensive trade could be influenced by a substantial growth in the labor demand of exporters in the comparative advantage sector.

One of the more recent theoretical studies examining this connection is Egger et al. (2012), which incorporates the diversity of firms' strategies, and argue that an increase in the minimum wage will result in the removal of inefficient intermediate goods traders from the market, subsequently reducing exports. Another point of view is presented by Bai et al. (2022), the authors argued that increasing the minimum wage makes selection closer, so firms improve productivity when entry costs are more capital intensive. This model anticipates that as the minimum wage increases, the process of selection becomes more rigorous, leading to enhanced productivity at the firm level and improving export performance.

Therefore, based on the theoretical models, increasing the minimum wage depends on some characteristics of each economy and industry, primarily based on labor intensity or capital intensity. Moreover, there is no consensus about the exact effect of changes in the minimum wage on export behaviour, so it will be crucial to observe what the empirical literature found about this relationship.

To begin, the relationship between minimum wage increases and export performance has been widely studied, yielding diverse results. For instance, Bai et al. (2022) explored this in the Chinese economy from 1998 to 2007, finding that a 10% increase in the minimum wage led to a 4.4% boost in firm productivity. This study, employing an instrumental variable strategy, highlighted the importance of capital-labor ratios in mediating the impact of labor costs on productivity. Similarly, Gan et al. (2016) utilized micro-level data from Chinese manufacturing firms, using a linear probability model to show that increased minimum wages reduce the likelihood of exporting. Their findings indicated that a 10% rise in the minimum wage corresponded to a 0.8 percentage-point decrease in export probability and a 0.9% reduction in export values. These studies collectively underscore the nuanced effects of labor costs on productivity and export behaviour, revealing both negative and positive outcomes depending on the specific economic context.

Another relevant empirical study was made by Ni et al. (2020), the authors extended this analysis to Indonesia, using firm-level data from 2002 to 2014 and a difference-in-differences (DiD) methodology. They found that higher labor costs reduced employment and productivity but increased the propensity to export and profit. This paradoxical finding was attributed to the dynamic adjustments firms make in response to changing labor costs, with quantile regression further highlighting the roles of firm size, experience, and education level. In addition, Nguyen (2021) provided a complementary perspective by examining the Vietnamese manufacturing sector from 2010 to 2015. Applying DiD methodology, Nguyen discovered that minimum

wage increases did not affect the propensity to export but positively impacted export values, particularly for low-productivity, labour-intensive firms. This suggests that minimum wage hikes can sometimes enhance export performance by driving firms to improve efficiency and competitiveness.

For the Turkish economy, Akgündüz et al. (2019) investigated Turkish firms from 2013 to 2016, employing DiD methodology to show that a 10% increase in labor costs led to a 3.1% reduction in exports. This study included control variables such as employment, wages per employee, and firm size, providing a robust analysis of the impact of labor costs on export performance.

In Latin America, there still a gap about empirical evidence showing the relationship between minimum wage and export performance, usually the impact of minimum wage policies has also been studied on labor outcomes. For example, Choi et al. (2021) analysed Ecuador's labor market in 2008, revealing reduced labor demand following minimum wage increases. Arango et al. (2020) found that higher minimum wages in Colombia increased informality, especially in low-productivity regions. These findings align with Bell (1997) and Lemons (2009), who studied Mexico and Brazil, respectively, and found no significant impact of minimum wage increases on formal sector employment or wages.

Turning to Peru, the lack of empirical evidence about minimum wage and export dynamics is bigger, however there are some studies the evaluate the effect of minimum wage on labor variables. For instance, Jaramillo (2004, 2012) highlighted the varying effects of minimum wage changes on formal and informal sector workers. In addition, Del Valle (2009) found that minimum wage increases negatively impacted formal sector employment while boosting informal sector employment. This finding highlights the relevance to consider the informal sector a key factor under the dynamic of labor cost. This dichotomy was further explored by

Cespedes and Sanchez (2013), who identified a 10% minimum wage increase leading to a 2.5% reduction in employment, particularly in small businesses. The Ministry of Employment (2022) provided the most recent analysis, estimating a short-term positive effect on wages but no significant impact on job retention following minimum wage increases.

Given the objectives of this research, it is crucial to examine how firms in developing countries respond to increases in the minimum wage, particularly in an environment where informality is a predominant characteristic. Usually, the relationship between informality and trade is analysed in terms of how trade liberalization impacts levels of informality. Empirical studies provide mixed findings, with some suggesting that trade openness can reduce informality and lead to welfare gains, while others identify mechanisms through which trade liberalization might increase informality, depending on the specific labor market conditions and the strength of regulatory enforcement.

However, this research will analyse informality as a crucial factor that could influences the heterogeneous effects on firms' export behaviour from changes of the minimum wage. The definition of informality used characterizes a worker as informal if they do not receive benefits, are not registered with tax authorities, and their employer unlawfully evades labor market regulations, including minimum wage laws and other legal requirements (Dix-Carneiro et al., 2024). This definition allows for a nuanced exploration of how varying levels of informality regions might alter the impact of minimum wage increases on export performance of firms.

There are studies have examined how informality influences labor market adjustments during episodes of trade liberalization. In Latin America, Goldberg and Pavcnik (2003), Dix-Carneiro and Kovak (2019), and Ponczek and Ulyssea (2020), consistently finds that trade liberalization often leads to an increase in informal employment, particularly in the most affected sectors or

regions. These findings suggest that the informal sector can act as a buffer for workers displaced by trade, reducing the severity of potential unemployment increases.

Dix-Carneiro et al. (2024) provide a framework that highlights how informality interacts with international trade dynamics. Their model demonstrates that in environments with a sizable informal sector, the benefits of trade are notably enhanced, as lowering trade barriers leads to a shift of resources from firms that were initially less distorted to those that are more distorted.

In Peru, Cisneros-Acevedo and Ruggieri (2023) further explore the dynamics between informality and labor market outcomes, revealing mechanisms that drive informality and how it affects broader economic performance. Their findings argue that a reduction in corporate taxes boosts efficiency by concentrating employment in larger, productive firms and reallocating workers to formal jobs. However, it also leads to longer unemployment durations and increased income inequality.

Moreover, Paz (2014) offers insights into how trade policies influence informal labor markets, which can be applied inversely in this research to understand how informality might affect firms' responses to increased labor costs due to minimum wage hikes. Firms in high-informality regions might struggle to meet international standards, affecting their export performance, but they also gain flexibility in managing labor costs. Adding another layer to this analysis by highlighting that informal producers are crucial in developing economies, Toksoy (2021) argue that informality provide low-cost inputs to formal producers and shaping their comparative advantage in global markets. These studies collectively illustrate the multifaceted effects of trade liberalization on informality, varying significantly across different South American economies and influenced by specific national policies and market conditions.

In summary, the literature predominantly uses DiD methodology to explore the effects of labor policies on exports, revealing diverse outcomes based on regional, sectoral, and firm-specific

characteristics. This body of work collectively underscores the complex interplay between labor costs, productivity, and export performance, highlighting the need for nuanced policy approaches tailored to specific economic contexts (Bossler & Gemer, 2020; Card & Krueger, 1993; Choi et al., 2021; Del Valle, 2009).

III. BACKGROUND

The Peruvian economy[3] is characterized by high levels of inequality, informality, and political instability. Despite these challenges, it has demonstrated recent stability and consistent economic growth when compared to other Latin American economies.

In Peru, according to the National Household Survey (ENAHO) 2022, the economically active population (EAP) is 19.6 million people; this represents 63.7% of the total population. (INEI, 2022). The composition of the employed EAP shows that wage earners represent 45% of the employed EAP, and 40% belong to the formal sector. In addition, the average salary of this group of workers reaches the value of around 670 US dollars (S/ 2,598 Peruvian soles); that is, almost three times the minimum wage (2.79). In the year 2021, workers who earn the minimum wage represent around 29% of the workers in the private sector. (MTPE, 2022).

The distribution by firm size shows that of those workers who have a salary of up to 265 US[4] dollars (S/ 1,025 Peruvian soles), 41% work in companies with 1 to 10 workers, 13% in firms with 10 to 100 workers, 13% in companies with 100 to 500 and 31% in large firm with more than 500 workers; That is to say, small companies and large companies are those that concentrate the most significant number of workers who are at a threshold “close” to the minimum remuneration (MTPE,2022).

[3] Peru is categorized as a lower-middle-income country, with a nominal GDP per capita of USD 6,725 in 2022, according to the World Development Indicators (2023). The primary drivers of Peru's economy are the mining, agriculture, and tourism sectors.

[4] That value is the actual minimum wage value since 2022.

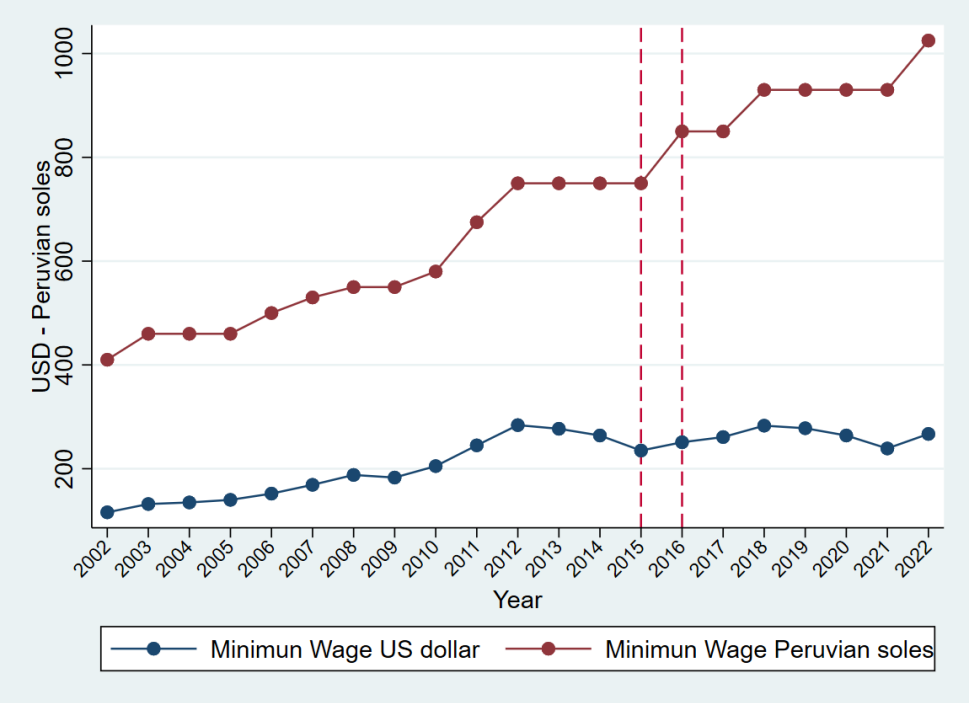
Regarding how the Peruvian government set the minimum wage, the Peruvian National Constitution specifies that the State must set minimum wages with the participation of representative organizations of workers and employers. In addition, the technical institution that supports this minimum wage setting is the National Council for Labour and Employment Promotion (CNTPE) (ILO,2016). This institution considers the inflation rate and productivity to recommend changes in the minimum wage in Peru since 2007. However, in fact, this minimum wage setting involve more political factors than technical analysis. Therefore, the increase is based on government discretion. Taking in account this characteristic, there is a possibility of taking this shock as a natural experiment to evaluate.

The focus of this research is evaluating the increase of minimum wage as a natural experiment. In May of 2016, there was an increase in the minimum wage from 750 to 850 Peruvian soles[5], which means from 235 to 251 US dollars. This increase represents a variation of 13% of the value (Central Bank of Peru, 2022). It is essential to clarify that this increase was released for the whole country, without differences between departments[6] or economics sector.

[5] The Peruvian law N°005-2016-TR for that minimum wage increase was published on 31st March 2016.

[6] Departments are the main political and territorial division in Peru, considering 25 departments in total.

Figure N°1 - Minimum wage in Peru from 2002 to 2022, US dollars and Peruvian currency



Source: Central Bank of Peru (2022). Note: This graph shows the evolution of nominal value of minimum wage in Peru in the last 20 year in Peruvian currency and in American dollars.

Regarding to export environment in Peru, the export sector has had sustained growth from 2017 to 2022, with an average annual growth rate of 9.6%. (COMTRADE, 2023). Peru's main export products are minerals, agriculture, and fishing. In 2022, minerals represented 57.2% of total exports, agricultural products 19.3%, and fishery products 12.5%.

IV. DATA

The main advantage of this research is employing administrative data at firm level, that contain the whole universe of firms in Peru. First, this research will employ a national directory of firms that operate in the Peruvian economy provided by SUNAT, the tax institution in Peru. This data is an administrative resource that contain information at firm level regarding main information such as location, economics sector, size of the firm, number of workers and years of experience. Therefore, this research constructs a balanced panel of firms during the period

2014 to 2017, to avoid bias effect from other changes in minimum wage in Peru, before and after that period.

Secondly, to get information about the export performance of firms, the company identifier was employed to merge the SUNAT directory of firms with the customs dataset provide by the same institution. This dataset contains specific details about export information for all firms that sell abroad. Therefore, we could identify enterprises that exported from 2014 to 2017 and construct different export outcomes. For instance, this database contains the value of exports (nominal American dollars), export markets, and products for each month and year[7]. Hence, the primary outcome variables were constructed from this information that will allow to estimate the effect of the intensive and extensive trade margin.

The final dataset only keeps firms that appear in the directory the four periods to make a balanced panel and avoid firms that close or enter to the market during this period. In addition, we delete non tradable sectors to have a consistency in the interpretation of results about the universe of firms that operate in international markets.

Finally, to construct our treatment variable that will reflect the level of exposure of minimum wage over average wage (by Department and CIIU level) and informality level, we employ National Household survey (ENAHO). The ENAHO survey gathers data from both urban and rural areas across Peru's 25 departments. The data collection was conducted through interviews by trained field personnel who visited the same households annually. The sample selection was probabilistic, area-based, stratified, multistage, and independent for each department. The survey covers various topics, including household and member characteristics, health, employment, income, and ethnicity.

[7] It is important to clarify that only the custom data is disaggregated at monthly frequency, however the directory of firms is provided annually.

Table N°1 – Variables Description for the period 2014-2017

Variable	Unit	Description	Obs	Mean	Std. Dev.	Min	Max
Export status	Dichotomic	Takes value 1 if the firm export in that year, 0 otherwise.	2,075,668	0.0097	0.098	0	1
Export value	US dollars	Log of value of export per firm.	20,133	11.7	2.8	0	21.9
Number of markets	Units	Countries of export destination per firm.	20,133	3.385	5.08	1	64
Number of products	Units	Products exporter per firm as 10-digit HS national code.	20,133	7.657	16.5	1	304
Firm Size	Category	4 categories of firm size: Micro, Small, Medium and Large.	2,075,668	1.089	0.37	1	4
Number of Workers	Category	7 categories of number of workers in each firm.	2,075,668	1.083	0.48	1	7
Sales	Category	15 categories of annual sales value in each firm.	2,075,668	2.57	2.57	1	15
Department	Code	Code of the location of the firm by department (2 digits).	2,075,668	--	--	1	25
Province	Code	Code of the location of the firm by province (4 digits).	2,075,668	--	--	0101	2504
District	Code	Code of the location of the firm by district (6 digits).	2,075,668	--	--	010101	250401
Sub- industry (CIIU)	Code	3-digit code of CIIU rev 4.	2,075,668	--	--	01110	52600
Exposure by Department	Percentage	Percentage of workers between 750 and 850 Peruvian soles by department (25 departments).	2,075,668	6.02%	1.86%	0.04%	10.2%
Exposure by CIIU	Percentage	Percentage of workers between 750 and 850 Peruvian soles by CIIU. (101 categories)	2,052,707	9.29%	8.58%	0%	100%
Informality Rate by Department	Percentage	Percentage of workers in job without benefits stipulated by law by department (25 departments).	2,075,668	76.6%	6.06%	59%	91%

Note: This table show the balanced panel data for four years (2014-2017) of the whole universe of Peruvian firms that operated in the economy. Non-tradable sectors were deleted of this data, and firms that close or open during this four years period are not taking in account. In sum, the final number of firms in every year is 518,917.

V. EMPIRICAL SPECIFICATION AND METHODOLOGY

This research will estimate the effect of an increase in wage on the export performance of Peruvian firms and the role of informality under these dynamics, focusing in its impact on trade margins. Based on Brecher (1974) and Flug and Galor (1986), we expected a negative relationship between an increasing minimum wage and firms' export performance. Moreover, we must consider the relevance of informality under this mechanism and how it could influence that expected impacts.

To begin, this research proposes to employ a local labor market approach to setting the level of exposure to minimum wage of firms. This method leverages variations in regional treatment intensity, if the more a minimum wage impacts the regional wage distribution, the greater the effect on the regional labor market will be. This treatment will follow Card (1992) approach, the author describes how comparing the results of geographic units with a higher proportion of workers directly affected by increases in the minimum wage could reflect the causal effect of interest.

To complement this approach, this research will follow the setting of the treatment variable of Jimenez (2023) for Peru, where the exposure treatment variable is defining by percentage of workers in the formal sector with wages between 222 to 252 US dollars (750 and 850 Peruvian soles) in 2015 by each department. The main intuition behind is that workers who are above or equal to the previous minimum wage and less than the new minimum wage value are the most likely to be affected by this policy (Caliendo et al 2018).

One assumption to support the relationship between exports and changes in labor cost is the elasticity of export demand, establishing that sales respond significantly to changes in price. This is important because an increase in the minimum wage could lead to increased production

costs and, therefore, an increase in export prices. Therefore, an increase in labor costs reduces competitiveness in international markets.

Therefore, according to the economic evidence reviewed and available data, this research proposes using a difference and difference methodology to estimate the effect of a public policy such as an increase in the minimum wage on firms' export behaviour.

According to Gertler et al. (2016), the difference-in-differences (DiD) approach compares outcomes over time between a treatment group, which experiences the intervention, and a comparison group. The first difference measures changes within the treatment group before and after the intervention, controlling for constant factors over time. The second difference accounts for external factors by comparing the changes between the treatment and control groups, thus isolating the effect of the treatment.

Under certain assumptions, such as the parallel trends assumption—which posits that the mean outcome changes for both groups are similar absent the treatment—DiD can estimate the average treatment effect on the treated. This means calculating the effect of the intervention specifically on those units that received it, by comparing their actual outcomes with the estimated outcomes had they not received the treatment. The control group serves as a counterfactual to construct this estimate.

The main idea of using this methodology is to compare the change in export outcomes of firms that are more likely to be affected by the change in minimum wage in Peru before and after the shock in 2016, that firms will conform to the treatment group. In that sense, the treatment group will be compared with firms less likely to be exposed to public reform during the same years. Under this technique, we can compare the difference in the export dynamics of the firms affected by the increase in the minimum wage and another group of firms unaffected by that public policy.

This methodology allows for discounting of the effects of those variables that cannot be observed but that are invariant over time and not attributable to the effect of changes in the minimum wage because, in the first difference, related to each group at the moment pre and post-intervention, the bias caused by permanent observable and unobservable differences of each group is eliminated, while the second difference, related to the treatment and control groups, the bias of common variable factors over time that affects both groups of firms. However, a limitation of this methodology is that it does not allow controlling for those unobservable factors that vary over time (Khandker et al., 2010). Therefore, under this methodology and according to the main model specification and the database, the core empirical equation to estimate will be:

$$Y_{it} = \beta_0 + \beta_1 \, post_t * treated_i + \beta_2 \, W_{it} + \gamma_t + \delta_i + \vartheta_m + \varphi_n + \epsilon_{it} \ldots (1)$$

Y_{it} represents the primary outcomes related to export performance. The first outcome is the propensity of exporting, the probability of exporting for firms. This outcome is related to the extensive margin and will capture how the change in minimum wage affect the decision to export of firms. The second group of outcomes is related to the group of exporters and will reflect the effect on intensive margin of trade, in that case we will analyse the effects on that subgroup of sample. The third and fourth outcomes corresponding to the number of products and markets exported, respectively[8]. In addition, $post_{it}$ indicates the post-treatment period, which takes the value of 1 if it is after 2016.

Therefore, β_1 capture the main effect to estimate[9], that coefficient will reflect the impact of change in minimum wage on export outcomes. Furthermore, the term W_{it} include controls variables related to characteristics of firms like firm size (measures in sales) and number of

[8] These outcomes only include the sample of exporters firms.
[9] An important point is that we do not consider the variables treated and post by itself because the fixed effects of years and firm are already in the equation.

workers. In addition, γ_t represent the fixed effect for year, δ_i will absorb the effect per firm, ϑ_m is the fixed effect for Peruvian department and φ_n means the fixed effect for sub-industry[10].

This specification will include years fixed effect; to capture other effects, they could change per year that could affect the interpretation of results estimated, for example some macroeconomics change such as exchange rates or economics cycles. Likewise, the specification will consider fixed effects related to firms to control for constant differences between firms. In that way, it can control for unobservable effects that could influence the export performance of firms, removing constant. We will follow the approach of Nguyen (2021); the author includes the fixed effects to vary by individual firms, industry, province, and time, thus eliminating the between-firm, industry, province, and time variation and better controlling for the specific economic shocks.

Regarding to the treatment variable, this will reflect the level of exposure of changes in minimum wage by department or economic sector (CIIU code – 3 digits). Based on the previous mentioned Jimenez (2023) approach, the exposure value is a percentage of workers that have a wage 222 to 252 US dollars respect to the total of formal workers in that department[11]. For the geographic approach, treated_{it} is a binary variable that takes value one if the firm is located in a department that have high levels of exposure to change in minimum wage in 2015, exposure value above the median over the distribution of departments.

By using a binary variable that indicates whether a department's exposure is above or below the mean, we will effectively capture the regional heterogeneity in how the minimum wage increase affects different areas. Following the Jimenez (2023) approach, this procedure will recognize that the economic and labor market conditions vary significantly across regions, which can influence the impact of a minimum wage. This method is useful in identifying

[11] This research will use the same definition in the case of the exposure variable at CIIU level.

whether certain regions, particularly those with higher exposure, experience more substantial effects on export dynamics.

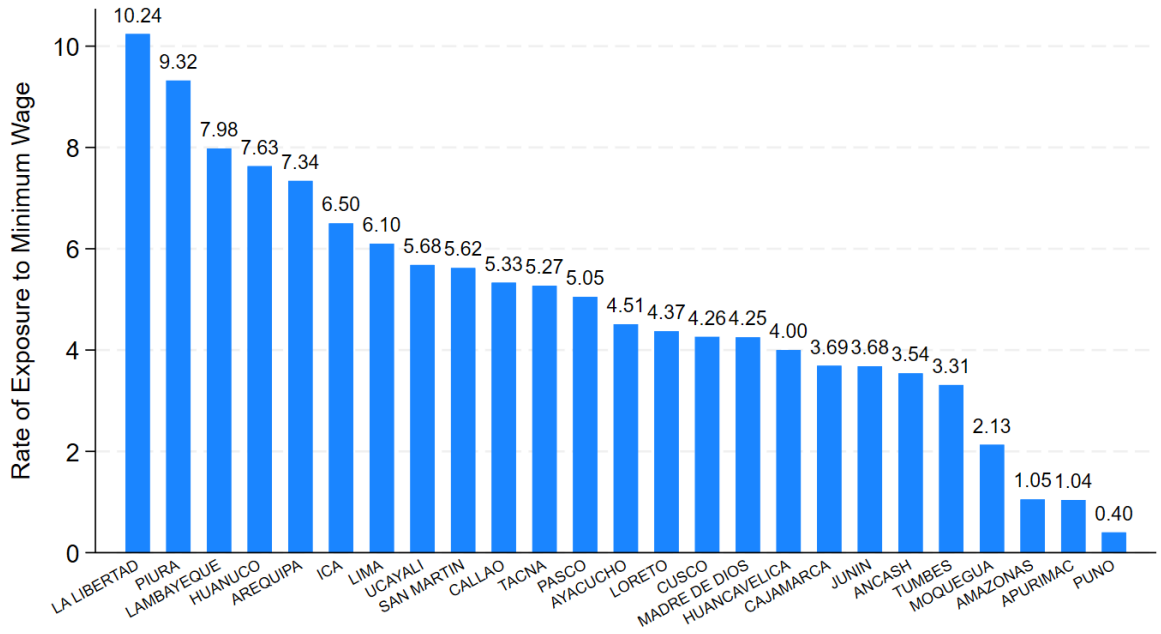
One main contribution of this research is to introduce a new measure of exposure to the minimum wage at sub-industry level, measuring exposure of minimum wage at the CIIU level using the continuous variable treatment[12] allows for a more nuanced understanding of how different industries respond to the minimum wage increase[13]. Industries might have varying degrees of sensitivity to labor costs based on their labor intensity, capital intensity, or market structure.

The continuous approach at the CIIU level reflects the sector-specific dynamics that might be masked in regional analyses. For instance, some industries within a region might be highly competitive internationally, and even a small increase in labor costs could have a significant impact on their export propensity. This approach allows for a detailed investigation into how specific sectors are differentially impacted by wage policy changes, providing valuable insights for industry-targeted policies.

Using both approaches allows for a more comprehensive analysis. The department-level binary variable provides a broad view of regional impacts, which is useful for policymakers concerned with regional development and equity. Meanwhile, the CIIU-level continuous variable offers insights into which industries might need additional support or face significant challenges due to increased labor costs.

[12] This approach will employ the rate of exposure as a continuous treatment variable.
[13] A continuous treatment variable at the industry level approach can capture these gradations more precisely than a binary measure.

Graph N°2 – Exposure levels to Minimum wage in 2015 by Departments



Source: ENAHO Survey 2015. Note: Exposure levels is defined as share of formal workers with wages between 750 and 850 PEN in 2015 in each Department.

To provide an alternative approach to measure the level of exposure to the minimum wage fluctuations, this research will use the rate of informality by department as a treatment variable in place of or alongside minimum wage exposure could provide several important insights and advantages in understanding the impact of labor market framework in developing economies on export dynamics.

In particular, this research will use the informality rate by department setting the treatment variable as a binary indicator that takes the value of 1 when a firm is located in a department with an informality rate below the median, indicating a less flexible labor market that is more vulnerable to increases in the minimum wage.

Informality is a key characteristic of many developing economies and represents a large portion of the labor market. In this way, capturing the true flexibility of the labor market, which is often overlooked when focusing solely on formal labor market regulations like minimum wage laws. The main goal behind this approach is that informality allows firms to adjust to changes in

labor costs without necessarily altering their formal employment structure, which can influence their competitiveness and export behaviour. In that sense, including this approach will provide the bid picture of the labor market and export performance relationship.

In order to analyse a possible underestimation of the effect of an increase in minimum wage regulation in Peru, because firms can rely on informal labor to circumvent the higher costs associated with formal employment. By analysing informality as a treatment variable, this approach will study whether this mechanism helps mitigate the negative effects of minimum wage exposure on export outcomes. This procedure can reveal how firms strategically use informal labor to maintain competitiveness in international markets, even when formal labor costs rise.

VI. RESULTS AND ROBUSTNESS CHECK

This section will present the main results per each outcome that reflects the exports performance of Peruvian firms by each treatment variable that reproduce the level of exposure to minimum wage.

Propensity to Export

To assess the impact of the minimum wage increase on the propensity to export, Table 2 presents a series of regressions that progressively incorporate different fixed effects and control variables. The primary variable of interest is the interaction term between the exposure to the minimum wage treatment by Department and the post-treatment period, which captures the differential impact on firms more exposed to the minimum wage increase.

Model 1 starts with a basic specification, including year and firm fixed effects, showing a statistically significant negative coefficient, suggesting that firms in more exposed to the minimum wage are less likely to export. As additional controls and fixed effects are introduced in Models 2 through 4, the magnitude of this negative impact remains consistent. In Models 5

through 9, firm size and the range of the number of workers are added as controls, and various fixed effects, such as department, sub-industry, and sub-industry*year, are considered. These adjustments confirm the robustness of the initial finding, with the interaction term remaining negative and statistically significant across all models. This negative relationship suggests that higher exposure to the minimum wage increase has a dampening effect on the likelihood of firms engaging in export activities.

Specifically, Model 6, which includes both firm size and the range of the number of workers as controls, along with department fixed effects, demonstrates the strongest negative impact. This implies that for firms with higher exposure to the minimum wage increase, there is a notable reduction in their propensity to export, likely due to the increased labor costs associated with the policy change. Therefore, for firms in departments with higher exposure to the minimum wage hike, the likelihood of engaging in export activities decreases by approximately 0.1 percentage points, holding all other factors constant.

This result suggests that the increase in labor costs due to the minimum wage policy may have made it less economically viable for these firms to participate in export markets. Firms likely faced higher production costs, which could reduce their competitiveness in international markets, particularly if they were operating with thin profit margins. Consequently, the increased cost burden may have led these firms to either exit export markets or avoid entering them altogether, thus explaining the observed reduction in export propensity.

On the other hand, the results presented in Table No. 3 illustrate the impact of minimum wage treatment exposure by CIIU on the propensity to export, using a continuous treatment variable. The analysis reveals a consistent and significant negative relationship between exposure to minimum wage at industry level increases and the likelihood of firms engaging in export activities across all model specifications.

Specifically, the coefficients for the interaction term between the CIIU-based exposure treatment and the post-period dummy are negative and highly significant across all models. These results suggest that as the exposure to the minimum wage increases at the sectoral level, the probability of firms exporting decreases. This negative impact persists even after controlling for firm size, the range of workers, and various fixed effects, indicating a robust effect of minimum wage exposure on export behaviour.

The inclusion of firm size and the range of workers as controls provides further insights into the mechanisms at play. The positive and significant coefficients for these variables across all models suggest that larger firms and those with a broader range of workers are more likely to export. However, the negative impact of minimum wage exposure remains significant even after accounting for these factors, highlighting the importance of considering sector-specific labor cost pressures when analysing export behaviour.

Regarding to the third treatment variable, the results displayed in Table 4 demonstrate the impact of exposure to minimum wage using informality rates, measured at the department level, on the propensity to export when interacting with the post-minimum wage increase period. Across all models, the coefficients for the interaction term *informality*post* are consistently negative and statistically significant, with the magnitude of the coefficients varying slightly depending on the inclusion of different fixed effects and control variables. This negative relationship suggests that firms located in departments with lower informality rates, and thus greater exposure to minimum wage increases, are less likely to maintain or increase their propensity to export following the policy change.

The results highlight that firms in regions with less informal labor markets are more adversely affected by increases in the minimum wage, as these regions lack the flexibility to absorb the higher labor costs without reducing export activities. This finding aligns with the hypothesis

that informality may act as a buffer against the negative effects of labor market rigidities, such as minimum wage increases, by providing firms with more flexibility in their labor arrangements. However, in regions where informality is lower, firms are less able to mitigate these cost increases, leading to a reduction in their export propensity.

Table N°2 – Results of Minimum Wage Treatment Exposure by Department on Propensity to Export

	Model1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Exposure treatment (Department)* post	-0.000923***	-0.000953***	-0.000948***	-0.000989***	-0.000983***	-0.00101***	-0.000671***	-0.000671***	-0.000671***
	(0.000288)	(0.000296)	(0.000302)	(0.000319)	(0.000323)	(0.000332)	(0.000216)	(0.000188)	(0.000124)
Size of firm				0.0239***		0.0223***	0.0221***	0.0221***	0.0221***
				(0.00417)		(0.00377)	(0.00375)	(0.00382)	(0.00104)
Range of number of workers					0.0125***	0.0102***	0.0103***	0.0103***	0.0103***
					(0.00105)	(0.000521)	(0.000536)	(0.000630)	(0.000890)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	NO	NO	NO
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Department Fixed Effects	NO	YES	YES	YES	YES	YES	YES	YES	YES
Sub-Industry Fixed Effects	NO	NO	YES	YES	YES	YES	NO	NO	NO
Sub-Industry * Year Fixed Effects	NO	NO	NO	NO	NO	NO	YES	YES	YES
Constant	0.0101***	0.0101***	0.0101***	-0.0159***	-0.00345***	-0.0252***	-0.0252***	-0.0252***	-0.0252***
	(0.000115)	(0.000115)	(0.000118)	(0.00445)	(0.00104)	(0.00416)	(0.00424)	(0.00439)	(0.00154)
Clustering	Department	Department	Department	Department	Department	Department	Department	Province	Firm
Observations	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668
F	10.30	10.35	9.855	17.76	115.4	138.0	143.0	93.48	189.1
r2_a	0.720	0.720	0.720	0.721	0.721	0.722	0.722	0.722	0.722

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using OLS regression with fixed effects. The outcome variable is Propensity to Export, which take value 1 if the firm export, and 0 otherwise. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the dummy exposure to minimum wage level at department level.

Table N°3 – Results of Minimum Wage Treatment Exposure by CIIU (Quantitative treatment) on Propensity to Export

	Model1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Exposure treatment (CIIU)*post	-0.0000518**	-0.0000518**	-0.0000537**	-0.0000514**	-0.0000607***	-0.0000573***	-0.0000573***	-0.0000573***
	(0.0000111)	(0.0000111)	(0.0000107)	(0.0000108)	(0.0000118)	(0.0000114)	(0.0000111)	(0.0000152)
Size of firm				0.0232***		0.0214***	0.0214***	0.0214***
				(0.00428)		(0.00385)	(0.00393)	(0.00104)
Range of number of workers					0.0134***	0.0110***	0.0110***	0.0110***
					(0.00109)	(0.000544)	(0.000619)	(0.000957)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Department Fixed Effects	NO	YES	YES	YES	YES	YES	YES	YES
Sub-Industry Fixed Effects	NO	NO	YES	YES	YES	YES	YES	YES
Constant	0.00960***	0.00960***	0.00961***	-0.0156***	-0.00486***	-0.0255***	-0.0255***	-0.0255***
	(0.0000541)	(0.0000514)	(0.0000495)	(0.00464)	(0.00115)	(0.00438)	(0.00449)	(0.00157)
Clustering	Sub-Industry	Sub-Industry	Sub-Industry	Sub-Industry	Sub-Industry	Sub-Industry	Province	Firm
Observations	2052566	2052566	2052566	2052566	2052566	2052566	2052566	2052566
F	21.67	21.58	25.06	17.38	76.82	160.1	111.1	181.3
r2_a	0.717	0.717	0.717	0.718	0.717	0.718	0.718	0.718

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using OLS regression with fixed effects. The outcome variable is Propensity to Export, which take value 1 if the firm export, and 0 otherwise. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the continuous variable of the exposure to minimum wage level at CIIU level.

Table N° 4 – Results of Informality rate treatment by Department on Propensity to Export

	(1) Model1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8	(9) Model 9
Exposure treatment informality*post	-0.001000***	-0.00100***	-0.00103***	-0.00116***	-0.00107***	-0.00119***	-0.000839***	-0.000839***	-0.000839***
	(0.000260)	(0.000259)	(0.000263)	(0.000272)	(0.000281)	(0.000282)	(0.000176)	(0.000154)	(0.000124)
Size of firm				0.0239***		0.0223***	0.0221***	0.0221***	0.0221***
				(0.00416)		(0.00376)	(0.00375)	(0.00381)	(0.00104)
Range of number of workers					0.0125***	0.0102***	0.0103***	0.0103***	0.0103***
					(0.00105)	(0.000519)	(0.000536)	(0.000630)	(0.000890)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	NO	NO	NO
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Department Fixed Effects	NO	YES	YES	YES	YES	YES	YES	YES	YES
Sub-Industry Fixed Effects	NO	NO	YES	YES	YES	YES	NO	NO	NO
Sub-Industry * Year Fixed Effects	NO	NO	NO	NO	NO	NO	YES	YES	YES
Constant	0.0100***	0.0100***	0.0101***	-0.0159***	-0.00346***	-0.0252***	-0.0252***	-0.0252***	-0.0252***
	(0.0000925)	(0.0000894)	(0.0000907)	(0.00448)	(0.00108)	(0.00419)	(0.00427)	(0.00441)	(0.00153)
Clustering	Department	Department	Department	Department	Department	Department	Department	Province	Firm
Observations	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668	2,075,668
F	14.82	14.91	15.21	17.35	81.28	130.4	123.7	88.70	191.9
r2_a	0.720	0.720	0.720	0.721	0.721	0.722	0.722	0.722	0.722

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using OLS regression with fixed effects. The outcome variable is Propensity to Export, which take value 1 if the firm export, and 0 otherwise. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the dummy informality rate treatment at department level.

Export Value Outcome

In analysing the impact of the minimum wage increase on the export values of firms, two common econometric approaches can be considered to get consistent results: the traditional Ordinary Least Squares (OLS) regression using the logarithm of export values and the Poisson Pseudo-Maximum Likelihood (PPML) estimation. Using the nominal value of export, each method has its distinct advantages and drawbacks, which are crucial in determining their suitability for this research context.

First, the OLS approach, particularly when applied to the logarithm of export values, is a conventional method that simplifies the interpretation of elasticities. However, it has limitations, especially under conditions of heteroskedasticity, as discussed by Santos Silva and Tenreyro (2006). The log-linearization process can lead to biased estimates when the data exhibits heteroskedasticity, meaning that the variance of the errors is not constant across observations. This bias can distort the elasticity estimates, making them unreliable. Furthermore, OLS excludes firms with zero export values from the analysis, potentially omitting valuable information about the impact of the minimum wage increase on firms that have ceased exporting or never started.

On the other hand, the PPML approach offers a robust alternative by addressing the issues associated with zero trade values and heteroskedasticity. Unlike OLS, PPML allows for the inclusion of firms with zero export values, thereby utilizing the full dataset and providing more comprehensive insights. This method is consistent even in the presence of heteroskedasticity and does not require the logarithmic transformation of the dependent variable, which can be advantageous when dealing with count data or variables with many zeros. However, a significant limitation of the PPML approach is its computational complexity, particularly when

incorporating firm-level fixed effects[14]. Additionally, PPML is not suitable for estimating elasticities directly from logarithmic transformations, as it works on the original scale of the dependent variable.

Under these circumstances, this research will present results using both approaches to examine the robustness and consistency of the findings. This dual approach ensures that the analysis is comprehensive, addressing the potential biases of each method while highlighting the broader implications of labor cost changes on intensive margin of trade.

The analysis of the results from the OLS regression where the treatment variable is the minimum wage exposure dummy by department is presented in Table N 5. The coefficient for the interaction term varies in magnitude and significance. In the initial models (1 and 3), the coefficients are positive but not statistically significant, suggesting that the minimum wage increase had a negligible or potentially positive effect on the export values for firms in highly exposed departments. However, as additional controls are introduced in Models 4 through 9, particularly when including the firm size, range of workers, and various fixed effects, the coefficient turns negative in Models 5 through 9. Despite these changes in sign, the coefficients remain statistically insignificant, which indicates that there isn't strong evidence of a direct and significant impact of minimum wage exposure on the export values when controlling for these variables. This lack of significance could suggest that while minimum wage increases may have some influence on export behavior, the effect might be more nuanced or mediated by other factors such as firm characteristics or the competitive environment in the department. Additionally, the strong significance of the control variables like firm size and the range of the number of workers, particularly in the later models, highlights their importance in explaining export outcomes, independent of the minimum wage exposure.

[14] When the regression includes firm level fixed effect, the sample was reduced around only 5% of the total observations.

Overall, these results suggest that while minimum wage increases might impose additional costs on firms, which could theoretically reduce export values, the actual impact in this context appears limited and not robust across different model specifications. This could imply that other factors or firm-level adaptations, such as adjustments in productivity or pricing strategies, might mitigate the direct effects of higher labor costs on export performance.

In Table No 6, the analysis is focused on evaluating the impact of minimum wage exposure by department on the export values using a Poisson regression approach. The results vary significantly across different models, highlighting the robustness of the relationship between the treatment variable and the export outcomes under various specifications.

In the initial models (Models 1 and 3), where the range of the number of workers are controlled without firm fixed effects, the coefficient for the minimum wage exposure treatment remains negative but statistically insignificant. This suggests that, in these models, the exposure to minimum wage increases does not have a statistically significant impact on the nominal export values. However, starting from Model 4, where additional fixed effects are introduced, the treatment variable turns positive and becomes significant in some models, particularly in Model 4 and 5. This indicates that, when accounting for other factors such as firm size, department-level fixed effects, and the range of workers, there is a positive relationship between minimum wage exposure and nominal export values. This could imply that, under certain conditions, higher exposure to minimum wage increases could potentially lead to an increase in export values, possibly due to firms adjusting their scale or productivity to cope with the higher labor costs.

However, when firm fixed effects are introduced in Models 7 and 8, which reduce the number of observations significantly, the coefficients for the treatment variable again become negative,

although still statistically insignificant. This reduction in observations is expected, as the inclusion of firm fixed effects limits the analysis to firms that have variation in the treatment variable over time. This suggests that the positive impact observed in earlier models might be driven by firm-level characteristics that are not adequately controlled for without firm fixed effects.

Overall, the results of the Poisson regression suggest a complex relationship between minimum wage exposure and export values, with the impact varying depending on the specific controls and fixed effects included in the model. The use of firm fixed effects highlights the importance of accounting for firm-specific factors that could influence the results, though it also limits the sample size and the generalizability of the findings.

Additionally, in Table 7, the results from the OLS regression (Models 1 to 4) and the Poisson regression (Models 5 to 8) are presented to analyze the impact of minimum wage treatment exposure by CIIU on export value, using both log-transformed and nominal values of exports as the dependent variable for each type of regression. The OLS regression models indicate a negative and mostly insignificant relationship between the minimum wage exposure treatment and the export value. The coefficients across these models remain small and statistically insignificant, with the exception of Model 4, where the coefficient is slightly larger but still does not show a significant impact. These results suggest that when examining the data using the OLS approach, the exposure to the minimum wage increase at the CIIU level does not strongly correlate with changes in export value. Additionally, the inclusion of firm size and the range of workers as control variables does not significantly alter the relationship, indicating a consistent lack of strong association under the OLS specification.

In contrast, the Poisson regression models (Models 5 to 8) reveal a different narrative. Here, the coefficients for the exposure treatment are negative and significant in several models,

particularly in Models 5 and 6, where the coefficients are -0.00996 and -0.01011, respectively. These results imply that higher exposure to minimum wage increases at the CIIU level is associated with a decrease in export value when considering nominal values of exports. However, in Models 7 and 8, where firm fixed effects are included, the significance of the coefficient diminishes, and the coefficient itself becomes smaller. This suggests that when controlling for firm-specific characteristics, the impact of minimum wage exposure on export value weakens. Overall, the Poisson regression results provide evidence that minimum wage exposure negatively affects export value, but this effect is sensitive to the inclusion of firm fixed effects, which may capture underlying firm-level factors that are not accounted for in the OLS regression models.

Finally, Table N 8 examines the impact of departmental informality rates on export value, comparing results obtained using OLS regressions and Poisson regressions. In the models employing OLS and Poisson regressions, the coefficients for the informality exposure treatment vary in sign and significance, indicating an inconsistent relationship between exposure of minimum wage using informality and export value that is sensitive to model specification.

The analysis of export value outcomes reveals that the relationship between minimum wage exposure and export performance is complex and varies depending on the model and controls used. OLS regressions, focusing only on exporting firms, show inconsistent effects, suggesting that the impact of wage policies may be influenced by factors like firm size and workforce characteristics. Conversely, Poisson regressions, which account for both exporting and non-exporting firms, generally indicate a positive relationship between wage exposure and export value, particularly in formal labor markets. However, this effect diminishes when firm-level fixed effects are included, emphasizing the significant role of firm-specific factors in determining export outcomes in response to wage increases.

Table N°5 – Results of Minimum wage treatment exposure by Department on Export Value (Log) using OLS

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Exposure treatment*post	0.00383	-0.00290	0.00280	-0.0420	-0.0336	-0.0784	-0.0654	-0.0654	-0.0654
	(0.111)	(0.108)	(0.110)	(0.0989)	(0.108)	(0.103)	(0.0948)	(0.0921)	(0.0811)
Size of firm				0.581***		0.581***	0.584***	0.584***	0.584***
				(0.0126)		(0.0180)	(0.0161)	(0.0138)	(0.0311)
Range of number of workers					0.116***	0.116***	0.139***	0.139***	0.139***
					(0.0197)	(0.0104)	(0.0111)	(0.0148)	(0.0141)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	NO	NO	NO
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Department Fixed Effects	NO	YES	YES	YES	YES	YES	YES	YES	YES
Sub-Industry Fixed Effects	NO	NO	YES	YES	YES	YES	NO	NO	NO
Sub-Industry * Year Fixed Effects	NO	NO	NO	NO	NO	NO	YES	YES	YES
Constant	12.02***	12.03***	12.02***	10.61***	11.69***	10.27***	10.19***	10.19***	10.19***
	(0.0507)	(0.0495)	(0.0503)	(0.0484)	(0.0792)	(0.0677)	(0.0498)	(0.0661)	(0.103)
Clustering	Department	Department	Department	Department	Department	Department	Department	Province	Firm
Observations	17,490	17,490	17,486	17,486	17,486	174,86	17,422	17,422	17,422
F	0.00119	0.000720	0.000648	1126.2	17.62	459.1	1148.2	933.3	128.0
r2_a	0.856	0.856	0.856	0.863	0.857	0.864	0.866	0.866	0.866

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using OLS regression with fixed effects. The outcome variable the value of export measure in log, considered only the universe of exporters. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the dummy exposure to minimum wage treatment at department level.

Table N°6 – Results of Minimum wage treatment exposure by Department on Export Value (Nominal values) using Poisson regression

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Exposure treatment*post	-0.0645	0.438***	-0.0445	0.199***	0.199***	0.233*	-0.0606	-0.0123
	(0.123)	(0.0746)	(0.0934)	(0.0631)	(0.0688)	(0.133)	(0.126)	(0.0975)
Size of firm		2.603***		2.030***	2.030***	2.000***		0.829***
		(0.118)		(0.0723)	(0.0632)	(0.122)		(0.0256)
Range of number of workers			1.071***	0.428***	0.428***	0.468***		0.0826***
			(0.0766)	(0.0368)	(0.0349)	(0.0755)		(0.0209)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	NO	NO	NO	NO	NO	NO	YES	YES
Department Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Sub-Industry Fixed Effects	NO	YES	YES	YES	YES	YES	NO	NO
Sub-Industry * Year Fixed Effects	NO	NO	NO	NO	NO	NO	YES	YES
Constant	11.35***	6.861***	10.48***	6.659***	6.659***	6.562***	19.03***	15.26***
	(0.0603)	(0.484)	(0.472)	(0.407)	(0.335)	(0.282)	(0.0616)	(0.177)
Clustering	Department	Department	Department	Department	Province	Firm	Department	Department
Observations	2,075,668	2,074,354	2,074,724	2,074,724	2,074,724	2,072,104	31,933	31,933

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using Poisson regression with fixed effects. The outcome variable the value of export measure in US dollars, considered only the universe of exporters. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the dummy exposure to minimum wage treatment at department level.

Table N° 7 – Results Minimum Wage Treatment Exposure by CIIU on Export Value (log and nominal values)

	OLS Regression				Poisson Regression			
	Model1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Exposure treatment (CIIU)*post	-0.000610	-0.000622	-0.00207	-0.00207	-0.00996**	-0.0101**	-0.00820**	-0.00820*
	(0.00202)	(0.00210)	(0.00174)	(0.00146)	(0.00406)	(0.00401)	(0.00398)	(0.00442)
Size of firm			0.564***	0.564***			0.827***	0.827***
			(0.0447)	(0.0321)			(0.121)	(0.0899)
Range of number of workers			0.135***	0.135***			0.0901*	0.0901***
			(0.0320)	(0.0156)			(0.0497)	(0.0235)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Department Fixed Effects	NO	YES	YES	YES	NO	YES	YES	YES
Sub-Industry Fixed Effects	NO	YES	YES	YES	NO	YES	YES	YES
Constant	11.98***	11.98***	10.19***	10.19***	19.04***	19.04***	15.26***	15.26***
	(0.0116)	(0.0122)	(0.159)	(0.101)	(0.00607)	(0.00624)	(0.707)	(0.463)
Observations	16,546	16,544	16,544	16,544	30,571	30,570	30,570	30,570
Clustering	Sub-Industry	Sub-Industry	Sub-Industry	Firm	Sub-Industry	Sub-Industry	Sub-Industry	Firm
F	0.0912	0.0875	55.99	110.5				
r2_a	0.853	0.853	0.861	0.861				

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using OLS and Poisson regression with fixed effects, respectively. The outcome variable is the value of export measure in US dollars for the Poisson specification and measure in log for OLS regression, considered only the universe of exporters. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the continuous exposure to minimum wage treatment at CIIU level.

Table N° 8 – Results Informality rate Treatment Exposure by Department on Export Value (log and nominal values)

	OLS Regression				Poisson Regression			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Exposure treatment informality*post	0.0139	0.0213	-0.0638	-0.0638	0.00356	0.00527	0.0111	0.0111
	(0.0726)	(0.0751)	(0.0686)	(0.0611)	(0.113)	(0.115)	(0.0870)	(0.0990)
Size of firm			0.581***	0.581***			0.830***	0.830***
			(0.0189)	(0.0309)			(0.0258)	(0.0847)
Range of number of workers			0.117***	0.117***			0.0824***	0.0824***
			(0.0104)	(0.0136)			(0.0217)	(0.0200)
Years Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Department Fixed Effects	NO	YES	YES	YES	NO	YES	YES	YES
Sub-Industry Fixed Effects	NO	YES	YES	YES	NO	YES	YES	YES
Constant	12.02***	12.02***	10.26***	10.26***	19.00***	19.00***	15.25***	15.25***
	(0.0316)	(0.0326)	(0.0615)	(0.0956)	(0.0539)	(0.0553)	(0.175)	(0.432)
Clustering	Department	Department	Department	Firm	Department	Department	Department	Firm
Observations	17,490	17,488	17,488	17,488	31,936	31,933	31,933	31,933
F	0.0366	0.0802	433.2	125.8				
r2_a	0.856	0.856	0.864	0.864				

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using OLS and Poisson regression with fixed effects, respectively. The outcome variable is the value of export measure in US dollars for the Poisson specification and measure in log for OLS regression, considered only the universe of exporters. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the dummy informality rate treatment at department level.

Exported Markets Outcome

The results displayed in Table 9 provide an in-depth analysis of the impact of three different exposure treatment variables—by department, CIIU, and informality rate—on the outcome of the number of exported markets, employing Poisson regression models across six different specifications.

Models 1 and 2 focus on the treatment of exposure to minimum wage increases at the departmental level. These models reveal a significant and negative impact on the number of export markets, with coefficients of -0.137 and -0.103, respectively. This suggests that firms located in departments with higher exposure to minimum wage increases tend to export to fewer markets. The inclusion of department-level fixed effects in Model 2 confirms the robustness of this result, indicating that higher labor costs induced by minimum wage hikes can reduce the ability of firms to diversify their export destinations.

Models 3 and 4 examine the exposure treatment by CIIU, where the treatment is measured as a continuous variable. The results here show a small and statistically insignificant impact on the number of export markets. These findings suggest that, when considering the exposure at the industry level (CIIU), the effect on export market diversification is less pronounced and not statistically significant, indicating that industry-specific factors may not be as influential as regional factors in determining export behaviour in response to minimum wage increases.

Models 5 and 6 shift the focus to the treatment based on the informality rate by department. Here, a lower informality rate (indicating higher exposure to formal labor market regulations, including minimum wage laws) is shown to have a significant negative impact on the number of export markets. This suggests that in departments with lower informality rates, where firms are more strictly bound by labor laws, there is a notable reduction in the number of markets to which these firms export when the labor cost happen.

The consistent inclusion of firm-level fixed effects over these models slightly reduces the sample size but reinforces the significance of the results. This indicates that while the sample size may decrease due to the inclusion of firm fixed effects, the fundamental relationships between the treatment variables and the number of export markets remain robust. This robustness underscores the critical role of labor cost structures, whether influenced by regional exposure to minimum wage increases or varying levels of informality, in shaping firms' export market strategies.

Table N°9 – Results of treatment variables on Exported Markets outcome (Nominal Value) using Poisson regression

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Exposure treatment*post	-0.137***	-0.103**				
	(0.0459)	(0.0456)				
Exposure treatment (CIIU)*post			-0.00147	-0.000379		
			(0.00324)	(0.000501)		
Exposure treatment informality*post					-0.114***	-0.0482
					(0.0394)	(0.0433)
Size of firm	1.198***	0.351***	1.178***	0.341***	1.198***	0.351***
	(0.0463)	(0.00731)	(0.0635)	(0.0237)	(0.0461)	(0.00731)
Range of number of workers	0.268***	0.0475***	0.285***	0.0549***	0.268***	0.0475***
	(0.0178)	(0.00278)	(0.0359)	(0.0177)	(0.0176)	(0.00283)
Years Fixed Effects	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	NO	YES	YES	YES	YES	YES
Department Fixed Effects	YES	YES	YES	YES	NO	YES
Sub-Industry Fixed Effects	YES	YES	YES	YES	NO	YES
Constant	-4.883***	0.438***	-4.985***	0.380***	-4.897***	0.412***
	(0.0958)	(0.0318)	(0.146)	(0.0964)	(0.0957)	(0.0348)
Clustering	Department	Department	Sub-Industry	Sub-Industry	Department	Department
Observations	2,074,724	31,933	2,052,596	30,570	20,74,724	31,933

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using Poisson regression with fixed effects. The outcome variable is the number of markets exported, considered only the universe of exporters. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the three variables of exposure to minimum wage using separately in each model (column).

Exported Products Outcome

The table N 10 presents the results of the Poisson regression analysis for the number of products exported by firms, considering various treatment variables related to minimum wage exposure, both by department and industry, as well as the informality rate at the department level. The outcome variable across all models is the count of different products exported at 10- digits Harmonized System code, allowing for an analysis of the impact of labor cost changes on product diversification in export markets.

In Models 1 and 2, the treatment variable is the minimum wage exposure by department. The coefficients for the interaction term are negative and statistically significant, suggesting that firms in departments more exposed to minimum wage increases tend to export fewer products after the policy change. This result highlights the potential adverse effects of increased labor costs on firms' ability to maintain or expand their product range in export markets.

Models 3 and 4 incorporate exposures by industry (CIIU) as the treatment variable. The interaction term here is not significant, indicating that when exposure is measured by industry, the minimum wage increase does not have a statistically significant effect on the number of products exported. This suggests that the impact of the wage increase might be more localized or dependent on specific departmental conditions rather than industry-wide characteristics.

Models 5 and 6 introduce the informality rate as the treatment variable. The negative and significant coefficients for the interaction term suggest that firms in departments with lower informality rates (and thus higher formal sector exposure) export fewer products following the wage increase. This finding is consistent with the idea that firms in more formalized regions face higher adjustment costs in response to increased wages, potentially reducing their capacity to sustain a diversified export portfolio.

Throughout the models, the control variables such as firm size and the range of the number of workers remain significant, with larger firms and those with a wider range of workers generally exporting more products. Additionally, the inclusion of firm fixed effects in the last model results in a significant reduction in the number of observations, reflecting the challenges of using firm-level fixed effects in a dataset dominated by zero outcomes. Nonetheless, the negative effect of exposure remains robust, underscoring the potential adverse impact of minimum wage increases on firms' export product diversification.

The regression analyses focusing on the outcomes of the number of exported markets and the number of exported products reveal important insights into the effects of minimum wage exposure. Across various models, consistently demonstrate significant impacts on these outcomes. Specifically, the results indicate that increased exposure to minimum wage hikes tends to reduce both the number of markets and products exported by firms. This suggests that the rising labor costs associated with such policy changes can constrain firms' ability to diversify their export portfolios, potentially limiting their competitiveness in international markets.

However, an intriguing observation arises when the exposure is measured using the industry-based classification (CIIU). The results show that the interaction term for CIIU-based exposure is not statistically significant for both the number of markets and products exported. This lack of significance could suggest that industry-wide exposure may not capture the heterogeneity of firms' responses to wage increases as effectively as department-based measures. A plausible hypothesis for this outcome is that the CIIU classification may not fully reflect the regional variations in labor market conditions, regulatory enforcement, or firm-specific characteristics that are crucial in determining how firms respond to increased labor costs.

Table N°10 – Results of treatment variables on Exported Products outcome (Nominal Value) using Poisson regression

	Model1	Model 2	Model 3	Model 4	Model 5	Model 6
Exposure treatment*post	-0.143**	-0.120**				
	(0.0688)	(0.0494)				
Exposure treatment (CIIU)*post			-0.00223	-0.00199		
			(0.00373)	(0.00138)		
Exposure treatment informality*post					-0.139**	-0.113***
					(0.0540)	(0.0379)
Size of firm	0.807***	0.324***	0.787***	0.322***	0.807***	0.324***
	(0.0215)	(0.0141)	(0.0996)	(0.0623)	(0.0214)	(0.0142)
Range of number of workers	0.410***	0.0714***	0.424***	0.0793***	0.410***	0.0718***
	(0.0125)	(0.00783)	(0.0569)	(0.0293)	(0.0125)	(0.00757)
Years Fixed Effects	YES	YES	YES	YES	YES	YES
Firm Fixed Effects	NO	YES	YES	YES	YES	YES
Department Fixed Effects	YES	YES	YES	YES	NO	YES
Sub-Industry Fixed Effects	YES	YES	YES	YES	NO	YES
Constant	-3.545***	1.708***	-3.585***	1.665***	-3.548***	1.702***
	(0.0464)	(0.0430)	(0.206)	(0.223)	(0.0411)	(0.0392)
Clustering	Department	Department	Sub-Industry	Sub-Industry	Department	Department
Observations	2,074,724	31,933	2,052,596	30,570	2,074,724	31,933

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Notes: This table show the results using Poisson regression with fixed effects. The outcome variable is the number of products exported, considered only the universe of exporters. The sample includes 25 departments over the period 2014 to 2017. The DID term are constructed using a time dummy "Post" interacted with the three variables of exposure to minimum wage using separately in each model (column).

Event Study

An event study is a statistical technique commonly employed in economic research to examine the impact of a specific event or shock on economic outcomes. This approach aims to discern any noticeable abnormal returns or variations in export performance that can be attributed to the occurrence of the minimum wage policy change.

By systematically assessing how export-related variables react to the event date, this event study provides an initial assessment of whether and when any effects emerge, helping guide more in-depth analyses and potentially illuminating the causal relationship between the policy change and export outcomes[15]. This research will follow Carballo et al. (2022) approach, the main equation to estimate is:

$$Export\ Outcome_{it} = \sum \beta_t D_i [\text{post}_t * \text{treated}_i] + \gamma_t + \delta_i + \epsilon_{it} \ldots. (5)$$

D_i means each time variable dummy per month-year. The fixed effects δ_i and γ_t absorb unobserved differences across year and firms. In this research, the shock of increase of minimum wage happened in May 2016. However, this analysis will consider the based period in March 2016, when the Peruvian government realised the official law and all economics agents become aware about the increase of minimum wage. In addition, the analysis will include 12 months before and after the shock.

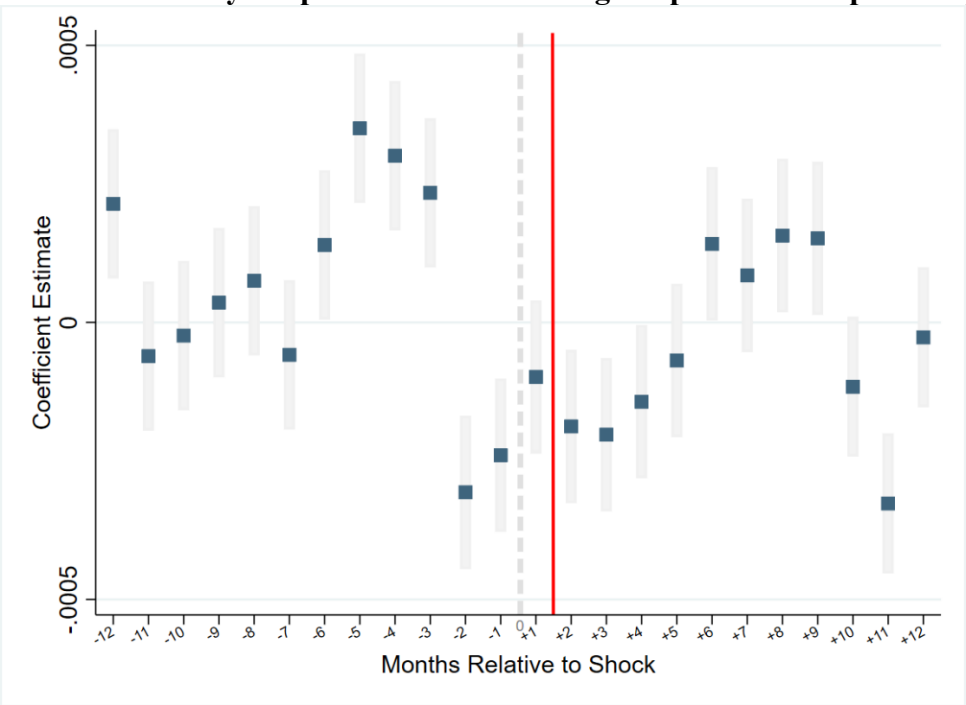
The event study analysis presented in the Figure N 3 provides insightful evidence regarding the impact of minimum wage exposure on firms' propensity to export, particularly in the context of the March 2016 legal announcement and the subsequent May 2016 implementation of the wage hike.

[15] This event study analysis will be generate using monthly frequency.

While there are fluctuations, the trends suggest that firms were able to partially adjust to the new labor costs over time, as indicated by the recovery in some of the coefficients post-shock. The fact that parallel trends are less consistent in these outcomes may suggest that other factors or adjustments (such as price increases or operational efficiencies) might be at play, influencing the firms' ability to maintain export levels despite higher labor costs.[16]

Following the announcement (dashed line) and especially after the implementation of the wage hike (solid red line), there is a notable decline in the coefficients, signifying a negative impact on the outcomes, it is more pronounced on export propensity. This decline implies that firms, particularly those highly exposed to the minimum wage increase, began to reduce their export activities, likely due to the increased labor costs making exports less viable. The return of the coefficients towards zero after several months may indicate an adjustment period where firms either adapted to the new cost structure or exited export markets altogether.

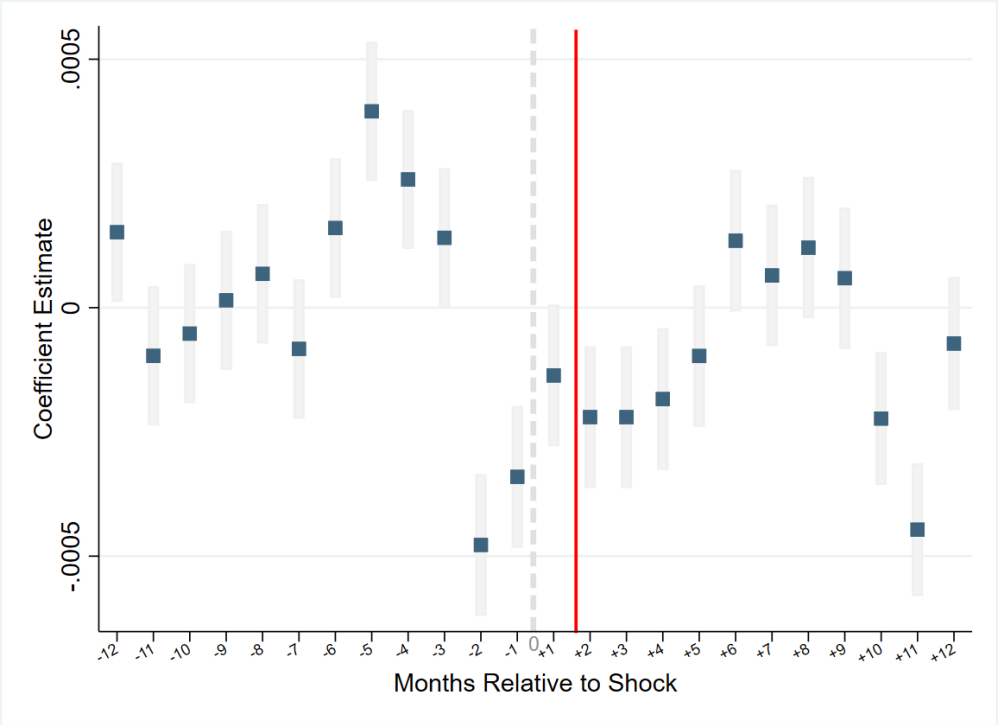
Figure N 3 - Event Study: Impact of Minimum Wage Exposure on Export Propensity



Note: Baseline period is March 2016, when the government start announced the increase in minimum wage (gray dot line). The official date of legal increase was 1sh May 2016, red continue line. This result employ OLS regression with firm and year fixed effect.

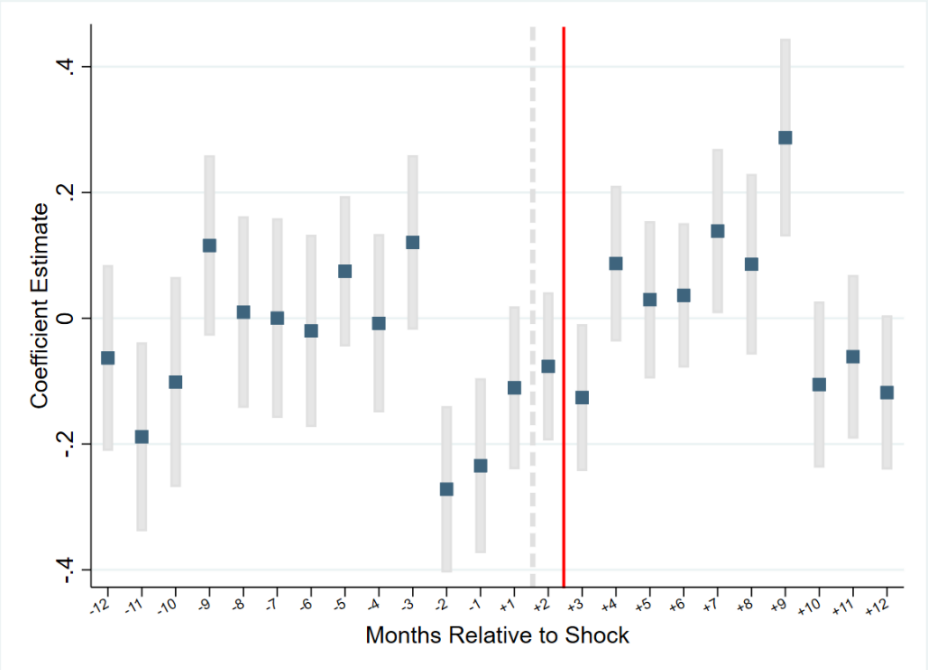
[16] The graph show some significant differences before the shock in March 2016, it could be caused by the nature od the dynamics in the export market during the end or beginning of each year.

Figure N 4 - Event Study: Impact of Informality Rate on Export Propensity



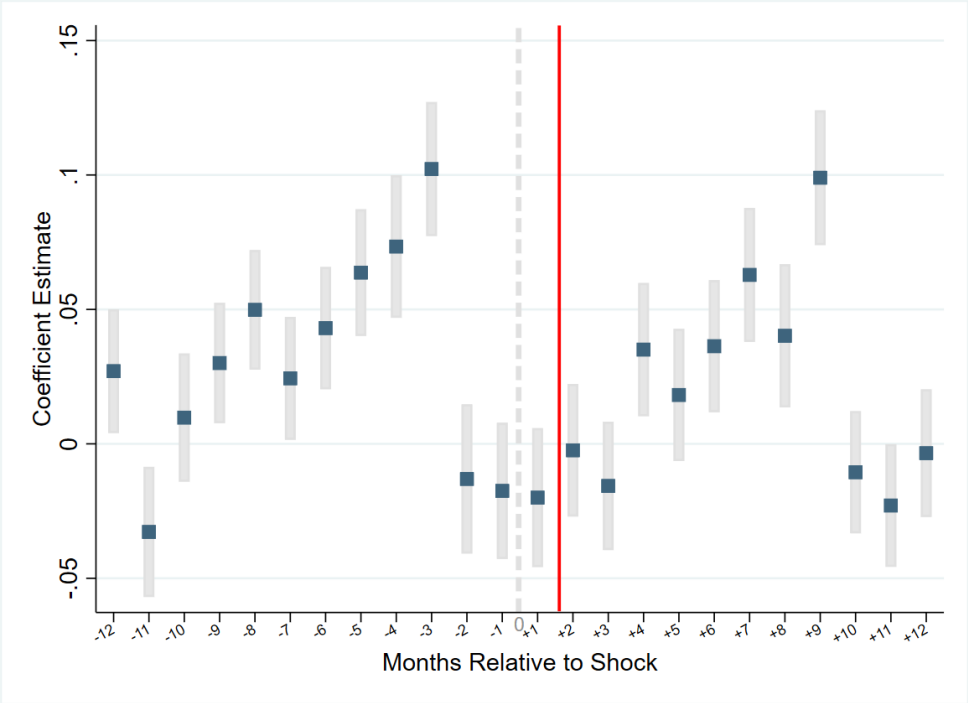
Note: Baseline period is March 2016, when the government start announced the increase in minimum wage (gray dot line). The official date of legal increase was 1sh May 2016, red continue line. This result employ OLS regression with firm and year fixed effect.

Figure N 5 - Event Study: Impact of Exposure to Minimum Wage on Export Value



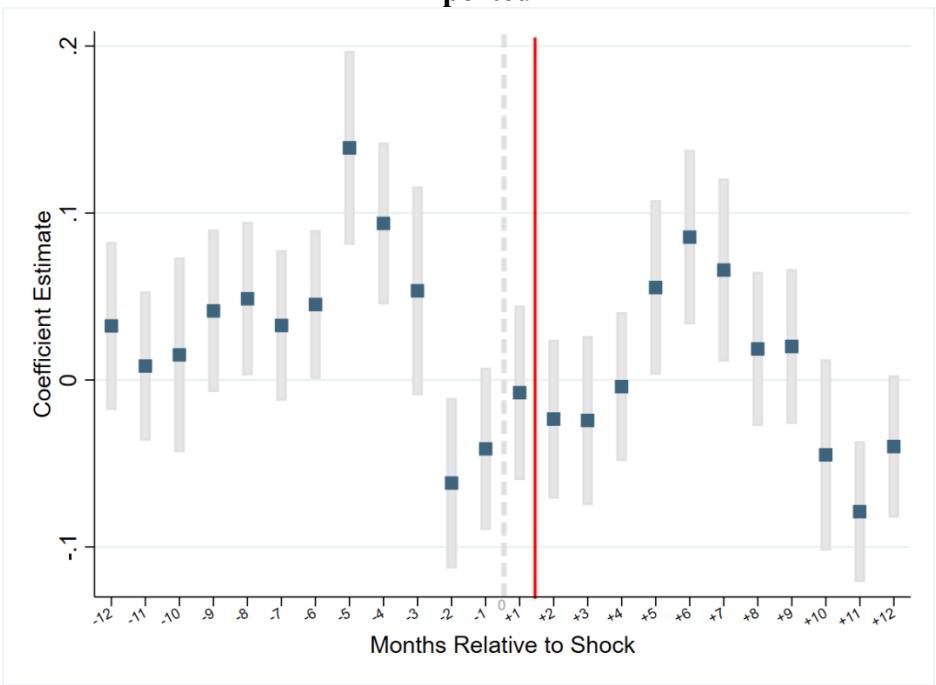
Note: Baseline period is March 2016, when the government start announced the increase in minimum wage (gray dot line). The official date of legal increase was 1sh May 2016, red continue line. This result employ Poisson regression with firm and year fixed effect.

Figure N 6 - Event Study: Impact of Exposure to Minimum Wage on Number of Markets Exported



Note: Baseline period is March 2016, when the government start announced the increase in minimum wage (gray dot line). The official date of legal increase was 1sh May 2016, red continue line. This result employ Poisson regression with firm and year fixed effect.

Figure N 7 - Event Study: Impact of Informality rate treatment on Number of Products Exported



Note: Baseline period is March 2016, when the government start announced the increase in minimum wage (grey dot line). The official date of legal increase was 1sh May 2016, red continue line. This result employ Poisson regression with firm and year fixed effect.

Robustness analysis

Short-Term Effects

To evaluate the sensitivity of the results, this research estimate models considering only the variable time in 2016. By excluding data from 2017, this approach analysis a shorter period after the policy change.

The short-term regression analysis presented in Table N 11 offers valuable insights into the immediate effects of minimum wage exposure (exposure treatment at department level) on various export outcomes in 2016. The negative and statistically significant coefficient for the treatment variable in the propensity to export and the number of markets models (Model 1 and Model 3) suggests that firms more exposed to the minimum wage increase were less likely to engage in exporting activities or diversify their export markets shortly after the policy change. This effect is particularly concerning as it may indicate that the policy could have created immediate barriers for firms in their export strategies. Conversely, the impact on export value and the number of products exported (Models 2 and 4) appears less conclusive, as the coefficients are negative but not statistically significant, implying that while there may be a downward trend, the short-term effects on these outcomes are not robust. Overall, these results highlight the potential immediate adverse effects of the minimum wage increase on firms' export behaviour, particularly in their decision to export and their market reach.

Table N° 11 – Results of Short-term Regression on Different Outcomes

	Propensity to Export	**Export Value**	**Number of Markets**	**Number of Products**
	Model 1	Model 2	Model 3	Model 4
Exposure treatment*post (2016 only)	-0.000697**	-0.0813	-0.0869**	-0.0570
	(0.000277)	(0.130)	(0.0354)	(0.0384)
Range of number of workers	0.0107***	0.128**	0.0266***	0.0208***
	(0.00111)	(0.0568)	(0.00514)	(0.00575)
Size of firm		0.965***	0.424***	0.477***
		(0.0227)	(0.00927)	(0.0116)
Constant	-0.00144	14.36***	0.289***	1.482***
	(0.00115)	(0.327)	(0.0286)	(0.0388)
Observations	15,56,751	22,152	22,152	22,152
F	67.14			
r2_a	0.731			

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Note: This table show result using OLS regression for the Model 1, and Poisson regression for the other specifications.

Medium-Term Effects

To evaluate the sensitivity of the results, we ran some models considering the variable time in 2017. Given that the change in the minimum wage took place in May of 2016, it is reasonable to expect the effects to become evident in 2017 for several reasons. First, firms typically require time to adjust their operations and strategies in response to increased labor costs, such as renegotiating contracts, restructuring costs, or modifying workforce size. These adjustments may not be immediately apparent but could manifest fully over the following year. Additionally, the impact on cash flow due to higher labor costs might not be felt instantly, as companies may initially absorb these costs but gradually start adjusting their pricing or operational strategies in 2017. Moreover, certain industries operate on annual cycles, meaning that the full effects of the wage increase would only be reflected in their 2017 budgets and sales forecasts. Lastly, market and consumer reactions to changes in wage levels also take time to materialize, influencing demand for products and services, and potentially affecting the overall

export performance of firms in 2017. These combined factors suggest that 2017 would be the year where the repercussions of the 2016 wage increase would be most visible.

This approach allows the isolation and examination of the impact of the policy change within 2017, separately from other years. By adopting this method, it becomes possible to directly analyze how the treatment effect evolves over time, providing a comparison of the medium-term effects observed in 2017 with the short-term effects from previous years, such as 2016. This strategy facilitates a clearer understanding of the temporal dynamics of the policy's impact.

The Table N 12 presents the results of a medium-term analysis focusing on the year 2017. The analysis reveals a statistically significant negative effect of the exposure to the minimum wage increase on the propensity to export and the number of markets reached, as evidenced by the negative coefficients in Models 1 and 3. This suggests that firms with higher exposure to the minimum wage increase were less likely to export and had a reduced reach in terms of the number of markets. However, the impact on the total export value and the number of products exported was not statistically significant, as shown by the coefficients in Models 2 and 4, indicating that while there was a deterrent effect on the decision to export and market expansion, it did not significantly affect the overall value or diversity of products exported by these firms. These findings suggest that the medium-term effects of minimum wage increases might influence firms' market strategies more in terms of reducing their market outreach rather than their overall export volume or product diversification.

Table N° 12 – Results of Medium-term Regression on Different Outcomes

	Propensity to Export	**Export Value**	**Number of Markets**	**Number of Products**
	Model1	Model 2	Model 3	Model 4
Exposure treatment*post (2017 only)	-0.000243*	-0.0783	-0.0644***	-0.0240
	(0.000136)	(0.0902)	(0.0226)	(0.0264)
Range of number of workers	0.0125***	0.0824***	0.0467***	0.0706***
	(0.00105)	(0.0208)	(0.00335)	(0.00824)
Size of firm		0.829***	0.351***	0.324***
		(0.0262)	(0.00730)	(0.0141)
Constant	-0.00376***	15.28***	0.411***	1.662***
	(0.00112)	(0.190)	(0.0274)	(0.0377)
Observations	2,075,668	31,933	31,933	31,933
F	114.1			
r2_a	0.721			

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Note: This table show result using OLS regression for the Model 1, and Poisson regression for the other specifications.

Placebo Test

A placebo test is conducted to verify the robustness and validity of the estimated causal effects in a study. This involves applying the difference-in-differences (DiD) analysis to an event that theoretically should have no impact, known as a "placebo." The placebo test can be performed using a fictitious treatment variable or by altering the timing of the treatment.

The primary purpose of a placebo test is to ensure that the DiD method correctly accounts for other potential influencing factors. If the placebo test reveals significant and unexpected impacts, it suggests that the original study results might be influenced by unconsidered factors. This test is designed to confirm that no significant effects are found in periods before the actual treatment, which would challenge the model's assumptions if such effects were detected (Gertler et al., 2016).

In this case, we will follow the approach to consider another prior time to set treatment. For example, the treatment will be set in 2015; the test will simulate the minimum wage change that happened one period before (2015) to analyse if there is a significant effect.

The placebo test results presented in Table No 13 provide insights into the validity of the original findings. The treatment period is shifted to 2015 to examine whether any effects are observed in a period before the actual policy change, serving as a falsification check. The results indicate that the exposure treatment post-2015 shows mixed and in some cases unexpected significance across the different outcomes. Specifically, there is a positive and significant coefficient for the propensity to export, which contrasts with the findings when using the actual treatment period. This suggests that any observed effects for the 2015 period could be spurious and reinforces the validity of the negative effects observed for the actual post-treatment period in 2016. However, the significant negative effect on export value suggests the possibility of some other underlying factors influencing exports during this earlier period, potentially questioning the robustness of the findings. The mixed results emphasize the importance of carefully interpreting the effects and underscore the need to consider alternative explanations or further robustness checks.

Table N° 13 – Results of Placebo test on Different Outcomes

	Propensity to Export	**Export Value**	**Number of Markets**	**Number of Products**
	Model1	Model 2	Model 3	Model 4
Exposure treatment* post (Placebo=2015)	0.000286**	-0.183**	-0.0335	-0.00403
	(0.000130)	(0.0753)	(0.0267)	(0.0458)
Range of number of workers	0.0125***	0.140***	0.0672***	0.0938***
	(0.00109)	(0.0372)	(0.00643)	(0.00964)
Size of firm		0.823***	0.348***	0.316***
		(0.0304)	(0.00811)	(0.0106)
Constant	-0.00389***	14.99***	0.327***	1.602***
	(0.00119)	(0.320)	(0.0281)	(0.0370)
Observations	2075668	31907	31907	31907
F	73.58			
r2_a	0.721			

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Note: This table show result using OLS regression for the Model 1, and Poisson regression for the other specifications.

Falsification Test

A falsification test is used to check whether the results could be driven by factors unrelated to the treatment. It involves applying the same analytical framework to a scenario where no effect is expected. For instance, applying the same methodology to a variable that should not logically be affected by the minimum wage increase. If there is a significant effect in these scenarios, it raises concerns that the previous results might be spurious or driven by unaccounted-for confounding factors.

For this purpose, this research will use the size of the firm as a outcome to prove the consistency of previous results. The size of the firm, in theory, should not be directly impacted by the minimum wage increase. This makes it a suitable candidate for the falsification test, as any significant effect observed on this variable would suggest that original model might be capturing some spurious correlation rather than a causal relationship.

The results in Table N 14 show that none of the interaction terms (exposure to treatment * post) are statistically significant across all models, with p-values far from conventional significance levels. This suggests that exposure to minimum wage increases does not have a significant effect on firm size, which aligns with expectations, as firm size should not be directly impacted by changes in minimum wage policies. This strengthens the credibility of the main findings, indicating that the effects observed in other outcomes (e.g., propensity to export, export value) are indeed due to the treatment rather than confounding factors.

Table N° 14 – Results of Falsification test on Firm Size Outcome

	Model 1	Model 2	Model 3	Model 4
Exposure treatment*post	0.00168	0.00140		
	(0.00473)	(0.00472)		
Exposure treatment informality*post			0.00540	0.00500
			(0.00413)	(0.00422)
Range of number of workers		0.102***		0.102***
		(0.0197)		(0.0197)
Constant	1.088***	0.978***	1.087***	0.977***
	(0.00184)	(0.0213)	(0.00143)	(0.0209)
Observations	2,075,668	2,075,668	2,075,668	2,075,668
F	0.126	13.59	1.707	17.86
r2_a	0.857	0.859	0.857	0.859

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Note: This table show result using OLS regression for the two main treatment variables, exposure treatment by department. The outcome is categorical variable Firm Size, which contain 4 categories (micro, small, medium and large).

VII. MECHANISM

The mechanisms underlying the observed relationship between minimum wage increases and export performance can be understood through a detailed examination of how labor cost changes propagate through a firm's operational and strategic decision-making processes. The initial link in this causal chain is the policy-induced increase in the minimum wage, which directly raises the cost of labor, particularly in sectors that are labour-intensive. This rise in labor costs can have several immediate effects on a firm’s cost structure, leading to higher overall production costs.

As firms face these increased costs, they must decide how to absorb or pass on these costs. In many cases, the ability to pass on higher costs to consumers is constrained by the competitive nature of international markets, where price sensitivity is often high. Firms competing in these markets might find it challenging to raise prices without losing market share, especially when their competitors are not subject to similar cost pressures. This situation forces firms to either absorb the costs internally, which reduces profit margins, or find other ways to offset the increase, such as by reducing other variable costs, which could include scaling back on production or cutting back on investments in areas critical for maintaining export competitiveness.

The next link in the chain involves the strategic decisions firms make in response to these cost pressures. For firms that are already exporting, the decision may revolve around whether to continue exporting, scale back export activities, or withdraw from export markets altogether. The added financial burden can make it less attractive or even unfeasible to maintain a presence in international markets, particularly for firms with thin profit margins or those operating in highly competitive sectors. As a result, these firms might reduce the number of products they

export or the number of markets they serve, focusing instead on domestic sales where they can more easily pass on costs or benefit from local competitive advantages.

Moreover, the decision to enter export markets becomes even more complex for firms considering international expansion. The higher labor costs act as a barrier to entry, particularly for smaller firms or those in industries where labor costs make up a significant portion of total expenses. These firms may be deterred from exporting due to the increased risks and reduced potential returns on investment, especially if they do not have the scale or resources to compete effectively on the global stage. Thus, the propensity to export is likely to decline as firms opt to focus on their domestic markets where they face less intense price competition and can better manage their cost structures.

Formal firms, which must comply with wage regulations, are directly affected by the wage hike, leading to increased production costs that are difficult to mitigate. In contrast, informal firms or formal firms that operated in high informality environment, which often operate outside the formal regulatory framework, are not subject to the same wage regulations and can maintain lower labor costs, giving them a competitive edge in both domestic and international markets. This flexibility allows informal firms to absorb cost increases more effectively, thereby preserving their competitiveness and continuing their export activities.

In summary, the chain of causality from minimum wage increases to export performance involves a complex interplay of cost pressures, strategic decision-making, and competitive dynamics. Firms must navigate these challenges by either absorbing costs, passing them on, or adjusting their market strategies, with significant implications for their export activities. The observed reduction in export propensity, particularly among firms in more formalized sectors or regions, underscores the importance of understanding how labor market policies can influence international trade dynamics.

VIII. CONCLUSION

In summary, the findings suggest that while minimum wage increases can act as a deterrent to firms considering exporting, those already engaged in export activities are less affected in terms of their export value, market diversification, or product range.

The findings of this study provide a nuanced understanding of how different treatment variables related to minimum wage exposure impact various export-related outcomes. The treatment variable based on departmental exposure to minimum wage increases consistently demonstrated a significant negative effect on the propensity to export, export values, the number of markets, and the number of products exported. Specifically, firms in departments with higher exposure to minimum wage hikes exhibited a marked decrease in their likelihood to export and a reduction in the diversity and scale of their export activities. This result underscores the sensitivity of export performance to labor cost increases, particularly in regions where the formal labor market is more prevalent.

Similarly, when the treatment variable was constructed using CIIU exposure (based on industry classification), the results mirrored the overall negative impact observed with departmental exposure. The CIIU-based treatment showed significant adverse effects on both the propensity to export and the number of export markets, although the effects on export value and product diversification were less pronounced. This suggests that industry-specific characteristics play a role in how firms respond to labor cost shocks, with some sectors being more vulnerable than others to minimum wage increases.

The use of the informality rate as a treatment variable also yielded critical insights. Firms in departments with lower informality rates, and thus greater exposure to the formal labor market, experienced more significant negative impacts on their export activities following the

minimum wage hike. This finding highlights the buffering role that informality can play in labor market adjustments to policy changes; in more formalized regions, where firms are less flexible in adjusting labor costs, the adverse effects on export performance are more pronounced.

In summary, the results of this study across all treatment variables and outcomes point to a clear and consistent pattern: higher exposure to minimum wage increases, whether by department, industry, or informality rate, is associated with negative consequences for firms' export activities. These findings emphasize the importance of considering regional and industry-specific characteristics when evaluating the broader economic impacts of labor market policies.

The robustness checks, including placebo and falsification tests, alongside the event study analysis, collectively validate the primary findings of this research. The placebo test, where the treatment was hypothetically applied in 2015, showed most insignificant effects, underscoring the genuine impact of the 2016 minimum wage increase on export outcomes. The falsification test using firm size, a variable unlikely to be affected by the wage hike, also showed no significant effects, further confirming that the observed changes in export behavior were specific to the treatment. The event study analysis revealed a clear pattern, with negative impacts on export propensity and value intensifying after the policy implementation in May 2016, and continuing in the following months.

However, while informality may offer short-term advantages by reducing exposure to cost increases, it is important to consider the long-term implications. Informal firms may struggle to access more regulated markets, face difficulties in scaling up, and have limited incentives to invest in productivity-enhancing technologies. Therefore, while informality may mitigate the immediate negative effects of minimum wage increases on export propensity, it may also limit

the potential for long-term growth and competitiveness in global markets. This will be the next steps for further research and examine how informality affect gain of trade for developing economies. In addition, next steps will be validating the results using different approach to test the consistency of these results.

Finally, this research highlights the importance of considering firm-level heterogeneity when assessing the impact of labor cost policies on international trade. Policymakers need to be aware that while wage increases may support domestic labor market goals, they could also unintentionally hinder the international competitiveness of firms, particularly those on the verge of entering export markets. It emphasizes the need for a balanced approach that considers the broader economic implications of labor regulations on trade.

In conclusion, the research underscores the complex relationship between informality, labor cost regulations, and export performance. It highlights how informality can buffer firms against regulatory cost shocks, such as minimum wage increases, thus preserving their ability to compete internationally. However, it also suggests that relying on informality may come at the cost of long-term development and market access, raising important considerations for policymakers aiming to balance labor market regulations with the need to enhance export performance.

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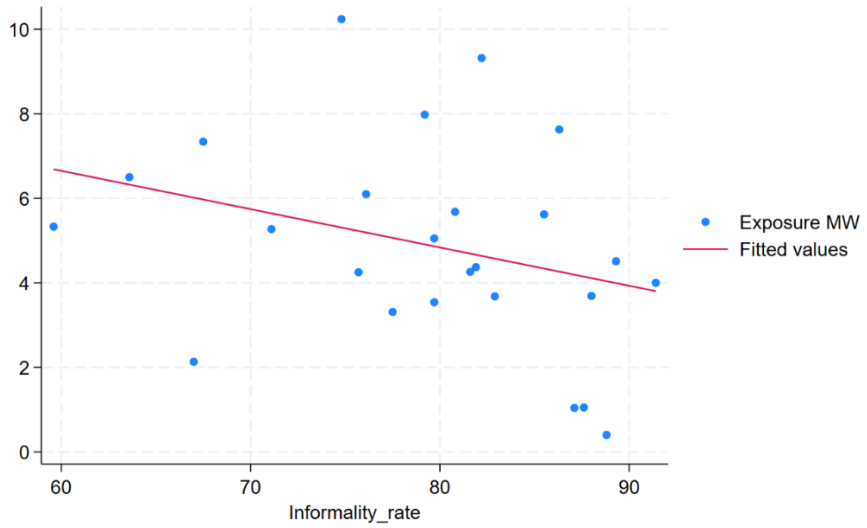
Appendix

A.- Informality rate vs Exposure to Minimum Wage by department



B.-Exposure to Minimum wage and informality rate by Region in 2016

Region/Deparment	Informality_rate	Treated_ Informality	Exposure MW	Treated_Exposure
Amazonas	87.6	0	1.05	0
Áncash	79.7	0	3.54	0
Apurímac	87.1	0	1.04	0
Arequipa	67.5	1	7.34	1
Ayacucho	89.3	0	4.51	1
Cajamarca	88	0	3.69	0
Callao	59.6	1	5.33	1
Cusco	81.6	0	4.26	0
Huancavelica	91.4	0	4	0
Huánuco	**86.3**	**0**	**7.63**	**1**
Ica	63.6	1	6.5	1
Junín	82.9	0	3.68	0
La Libertad	74.8	1	10.24	1
Lambayeque	79.2	1	7.98	1
Lima	76.1	1	6.1	1
Loreto	81.9	0	4.37	0
Madre de Dios	**75.7**	**1**	**4.25**	**0**
Moquegua	**67**	**1**	**2.13**	**0**
Pasco	**79.7**	**0**	**5.05**	**1**
Piura	**82.2**	**0**	**9.32**	**1**
Puno	88.8	0	0.4	0
San Martín	**85.5**	**0**	**5.62**	**1**
Tacna	71.1	1	5.27	1
Tumbes	**77.5**	**1**	**3.31**	**0**
Ucayali	**80.8**	**0**	**5.68**	**1**

Source: ENAHO Survey

C.- Directory SUNAT – Balanced Panel by year, Department and Exporters

Year	Freq.	Percent	Cum.
2014	518,917	25	25
2015	518,917	25	50
2016	518,917	25	75
2017	518,917	25	100
Total	**2,075,668**	**100**	

Department	Freq.	Percent	Cum.
Amazonas	2,391	0.46	0.46
Apurímac	3,465	0.67	1.13
Arequipa	31,863	6.14	7.27
Ayacucho	5,052	0.97	8.24
Cajamarca	9,529	1.84	10.08
Callao	15,260	2.94	13.02
Cusco	18,681	3.6	16.62
Huancavelica	1,964	0.38	17
Huánuco	7,230	1.39	18.39
Ica	14,904	2.87	21.26
Junín	18,822	3.63	24.89
La Libertad	28,591	5.51	30.4
Lambayeque	17,358	3.35	33.75
Lima	248,953	47.98	81.72
Loreto	8,083	1.56	83.28
Madre de Dios	3,863	0.74	84.02
Moquegua	3,268	0.63	84.65
Pasco	2,935	0.57	85.22
Piura	20,937	4.03	89.25
Puno	10,681	2.06	91.31
San Martín	10,195	1.96	93.28
Tacna	9,969	1.92	95.2
Tumbes	4,089	0.79	95.99
Ucayali	7,713	1.49	97.47
Áncash	13,121	2.53	100
Total	**518,917**	**100**	

Propensity to Export	Year				
	2014	2015	2016	2017	Total
0	513,624	513,712	513,994	514,202	2,055,532
1	5,293	5,205	4,923	4,715	20,136
Total	518,917	518,917	518,917	518,917	2,075,668

D.- Change in Exporting firms Share and Minimum wage Exposure by Department in 2016