Lisbon School of Economics & Management
Universidade de Lisboa

MASTER

ECONOMICS

MASTER´S FINAL WORK

DISSERTATION

INFLATION IN A TIGHT LABOUR MARKET: MEASURING THE DEGREE OF LABOUR MARKET TIGHTNESS AND THE MECHANISMS OF TRANSMISSION TO INFLATION

RICARDO NUNO SOARES FERREIRA DA SILVA FERNANDES

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SUPERVISION:
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GLOSSARY

BdP- *Banco de Portugal*

JEL – Journal of Economic Literature.

HPW- Heise-Pierce-Weber

LMT- Labour Market Tightness.

MFW – Master's Final Work.

NKBC- New Keynesian Business Cycle.

TLM – Tight Labour Market.

ABSTRACT, KEYWORDS AND JEL CODES

This dissertation analyses labour market tightness and if this impacts inflation pressures, specifically in Portugal, as this is a key factor in post-pandemic inflation dynamics. It uses a synthetic indicator, the HPW, to measure the labour market tightness in Portugal, which incorporates the quits rate and the vacancies-to-effective-job-seeker ratio. This indicator proves to be able to measure tightness better than the unemployment rate. Furthermore, through Granger tests of causality, it proves the influence of labour market conditions, such as the labour hoarding behaviour, on wage inflation pressures. These findings suggest that labour market imbalances are crucial for Portuguese wage dynamics.

Keywords: Labour Market Tightness; Inflation; Wage Dynamics; Labour Market Transmission Channels to Inflation.

JEL Codes: E31; F41; J21; J22; N3

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1. INTRODUCTION

Currently, and increasingly since the COVID-19 pandemic, inflation has been a significant concern for most economies, presenting itself as a challenge both to measure and to contain to normal, low levels. Economies are increasingly more global and exposed to multiple, different, external factors, such as international supply chains or the simple presence of tariffs or increased costs on imported goods. These make the accurate prediction of inflation and its maintenance at low levels, desired by policymakers, more difficult, as inflation greatly impacts the social condition of the population and their well-being.

Regarding this quantification problem, labour market conditions have been increasingly considered a major driver of inflation pressure, now a key focus of economic research on this topic. The COVID-19 pandemic significantly disrupted this market, an event that was clearly responsible for a spike in inflation pressures.

The labour market, characterized by both the demand for labour from employers and the supply of labour by workers, has suffered an increase in its tightness, which means that the demand for labour has increased. This has happened through multiple factors, such as the steep economic recovery after the shutdown in 2020, consequence of the heavy economic stimulus across most global economies, on a rhythm that the supply could not accompany, as supply was also affected by the restrictions and lockdowns imposed by the COVID-19 period, creating a shortage on the labour supply side and a consequent increase of its cost. This imbalance in the labour market is referred as Labour Market Tightness (LMT).

In line with the recent data for the inflation values in Portugal (INE, 2025), it is possible to observe the relevance that the labour market has on the Portuguese inflation levels and the influence this imbalance has on the overall inflation values, as this labour market tightness will impact the cost of labour to the employers. This will, next, affect the overall cost faced by a firm to produce, an event that will highly influence the inflation pressure levels across the economy, highlighting the relevance of the labour market tightness as a way to predict inflation pressures, information that is critical for policymakers to predict economic conditions correctly and to set policies accordingly.

The importance of a tight labour market (TLM) in predicting and quantifying the inflation conditions of the economy highlights the academic relevance and interest in further studying this economic phenomenon, emphasizing the empirical link between these two economic factors and the hypothesis that an accurate measurement of labour market conditions will significantly improve the capability to control and reduce inflation levels.

Although this is a known relationship, already studied and theorized, recently, the COVID-19 pandemic, highlighted this link and more concretely the fact that the degree of the tightness of the labour market will have a decisive impact on inflation levels, mainly through the pressures on wage inflation pressures (Bloesch, 2024). In an attempt to provide a better alternative to measure LMT, Heise et al. (2024), develops an alternative to the commonly used indicator of this finality, the unemployment rate, claiming the superiority of the indicator created, the Heise-Pierce-Weber (HPW) indicator. Furthermore, other researchers, such as Dvorkin & Marks (2024) and Felices (2003), have tried to analyse different channels through which this tightness is transmitted to the inflation level, providing insights into the relevance of the nominal wage rigidity and the labour hoarding behaviour as transmission channels into inflation.

These two different conditions of the labour market link to inflation, the measurement of the LMT and its transmission channels, have not been intensely studied in Portugal considering the recent pandemic changes, creating a gap in the empirical studies made about the Portuguese LMT and the Portuguese channels of transmission to inflation pressures, highly relevant to assess accurately inflation levels and mechanisms to control it, as this is an important problem for Portugal.

With this dissertation, the goal is to fill this gap in the Portuguese economic literature, concretely by testing this HPW indicator to the Portuguese labour market and the relevance of several mechanisms of transmission of LMT to inflation pressures in Portugal, clearly analysing the causality effect of these mechanisms. To do so, and to better study how the LMT affects the Portuguese economy, this Master Final Work will apply the HPW indicator to the Portuguese reality, testing firstly the foundations, such as the validation of the quits rate and the ratio of vacancies for job searchers as the two strongest measures of tightness in the labour market, as well as the foundations of this

indicator and the assumptions made to be able to use this indicator, applied to Portugal and secondly the capability of the indicator in measuring the LMT in Portugal, an indicator that, if proven as an effective indicator of tightness, can have explanatory power over inflation, being able to predict it more accurately than the other metrics used currently, especially the unemployment rate.

After the measurement of the tightness of the labour market, the transmission mechanisms of LMT to wage inflation pressures will be tested, resorting to a Granger causality test, in order to test if these channels have enough robust predictive relationships with inflation on the next period, such as the labour hoarding behaviour, where employers choose to sustain higher levels of workers, when facing a decrease on the demand for their product, to avoid the costs of rehiring and training new workers in the future, when the demand increases, or the bargaining power of the labour supply, where through different labour market conditions, the bargaining power the labour supply will have over the demand side will determine the remunerations.

To be able to test the HPW in Portugal correctly and to analyse the transmission mechanisms of LMT to inflation pressures for Portugal, this dissertation will rely on data from the Portuguese National Statistics Institute (INE), specifically the values for the inflation levels until 2024, from the Organisation for Economic Co-operation and Development (OECD), as well as definitions and assumptions by the European Foundation for the Improvement of Living and Working Conditions (Eurofound), such as the definition of the best indicator to analyse the transmission mechanisms of the LMT to inflation pressures, as the use of collective bargaining coverage values to accurately reflect the bargaining power of the labour supply. To use the Granger test, all variables had to undergo intermediate tests to ensure they met the test's assumptions, such as stationarity, as determined by the augmented Dickey-Fuller (ADF) test, to verify this stationarity.

After applying this methodology and incorporating the empirical data, the HPW has proved to be a robust indicator of tightness in the labour market. Then, by using a regression of the wage inflation against the indicator HPW (representing LMT), we show that it accounts for 61,2% of the inflation observed (R^2 of 0.612) highlighting the

predictive capability of this indicator to assess inflation pressures, as well as the existence of an important link between labour market conditions and inflation values.

To better measure this influence of the labour market and how it actually impacts in inflation pressures, the second phase of this empirical verification consisted on the definition of four proxies, representing four different transmission channels of LMT to inflation pressures - nominal wage rigidity, underutilization of workers, bargaining power of the supply side and the availability of the labour force - and then to test the causal relationship between these proxies and inflation using the Granger causality test. This test provides a clear insight into whether the variables (mechanisms) in one period have sufficient predictive value to confirm the relationship between them and wage inflation pressures in the next period, rather than a strict causality relationship. With the conclusion of the Granger test, it was possible to confirm the Granger causality between labour market conditions, acting as transmission channels, and wage inflation pressures, having the underutilization of workers and the bargaining power of the supply side proved to have the strongest influence over inflation levels. This highlights the importance of the behaviour of both the demand and supply side of labour to explain inflation pressures, through the aggravation of LMT that will, as proved by the Granger causality test, have an impact on wage inflation pressures.

This Dissertation helps to close an important gap in Portuguese economic research regarding the measurement of LMT, with the innovative application of the HPW indicator to the Portuguese reality, proving it as a trustworthy indicator of tightness, in addition to the explanatory power of this indicator regarding inflation pressures. Besides this, the analysis of the presence of transmission channels of LMT on wage inflation pressures also provides powerful insights into the relationship between these two economic factors, as well as the possibility for policymakers to assess future inflation pressures based on the current level of these mechanisms, gaining the possibility of creating policies to reduce inflation in the future by applying policies on the labour market, to control these mechanisms, as they are proven to be relevant to the definition of inflation pressures in the future.

In chapter 2 the literature review that supports this analysis is presented. After, the methodology will be exposed and the assumptions explained and lastly the empirical analysis and results of the calculations applied to Portugal are shown.

2. LITERATURE REVIEW

There has been a lot of focus and literature on the imbalance between the demand and supply of labour in the labour market and regarding the multiple transmission channels of these imbalances to the wage inflation pressures. However, the research on this topic reflecting the new conditions created by the COVID-19 pandemic is not that broad, as neither is the research on the impact of these new conditions on wage inflation pressures. This can be explained by the fact that this pandemic occurred not that long ago, and the result of this TLM in the economy is still recent or not fully materialized.

The different analyses conducted show that after the initial decline in demand due to lockdowns and sanitary measures adopted by various countries, there was a strong recovery, eventually surpassing supply levels, which contributed to the tightness of the labour market (Bloesch, 2024). As referred by Newman & Jacobs (2023), this demand increase in the labour market has reflected more in wage increases of the low-paying jobs, possibly because they are, from the start, the ones that offer the lower conditions. A good example used to reflect this scenario is the one of fast-food companies as they, facing scarcity in the supply of labour, were forced to, besides the increase on the nominal wage, offer other benefits, such as the payment of university tuitions or health insurance, that increased the cost of labour but was necessary to attract workers.

Supported by a New Keynesian Business Cycle (NKBC) model, Christoffel et al. (2009) provides a deep analysis focused on the unitary cost of labour. The author defends that this cost has increased because of the shortage of labour supply that pressures the labour demand to offer higher wages, increasing this unitary cost of labour and consequently the unitary and marginal cost for the employer, which will, in part, be absorbed by the increase of the final price, indicating inflationary pressures on the economy.

Also using a NKBC model, Mineyama et al. (2018), presents a different analysis, stating that a decrease in the nominal rigidity of wages has occurred which, along with the intensification of the LMT, contributed to a flattening of the Phillips Curve, the indicator of the relationship between unemployment and inflation. For the author, this

happened as, with the increased labour demand, the offered wages will be higher but, on the other hand, with an increase in unemployment, the wages will not vary that much, having then a smaller effect on Inflation than expected. This was what, according to the authors, was observed over and after the Great Recession, providing this way a historical explanation for this relation between the nominal rigidity of wages and inflation.

2.1. Measurement of the Tightness of the Labour Market

Historically, various indicators have been used to measure the imbalance between the demand and supply sides of the labour market, with the unemployment rate being the most commonly used (Heise et al., 2024).

As further analyses and research have been conducted on other indicators, some have proven to have a closer link to LMT than the unemployment rate, allowing for a better prediction and analysis of this labour market condition, such as the job vacancy rate (Hur & Chae, 2024). In this paper, it is noted that this indicator closely monitors the higher sensitivity of inflation to an increase in the TLM when inflation levels are already high, making this indicator useful for measuring the link between LMT and inflation.

Another important indicator is the quits rate, presented by Bloesch (2024) as the most important indicator of LMT. The author highlights the pro-cyclical aspect of the indicator, as in an economic expansion, the quits rate will be higher, which indicates a higher LMT, crucial for wage growth and inflationary pressures. Besides this aspect of the indicator, it also is pointed as a good measure of worker confidence, as a higher quits rate will mean that workers perceive that is easier to find another job. Even more, this paper also incorporates the Beveridge Curve, the relation between job vacancies and the unemployment rate, as a way of measuring the excessive demand for labour. According to the author, with the pandemic, there was an increase of labour demand and a decrease on the supply side, because of the sanitary measures and lockdowns, resulting in a worse matching efficiency between the supply and demand side, that results in a decrease in productivity of labour that further pressures inflation.

Heise et al. (2024), develops an indicator that, according to the paper, better measures this tightness, the HPW indicator. This indicator incorporates the quits rate, as it is stated that this measures effectively the confidence of the labour supply side in finding another job, as a tighter labour market would indicate it is easier for workers to find another job, and the rate of vacancies per effective searcher, employed and unemployed, which captures accurately the rate of competitiveness faced by the demand side. The authors believe these two indicators, individually, have a higher correlation with inflationary pressures on the economy than the unemployment rate, so the paper uses empirical data to compute the weight of each indicator in the aggregated one, the aforementioned HPW indicator. This was presented as the most correlated to inflation, rather than the unemployment rate, hence it is superior in measuring the tightness of the labour market and predicting the inflation pressure.

2.2. Mechanisms of Transmission of LMT to Wage Inflation

Dvorkin & Marks (2024) provides a deep analysis of the reduction of nominal wage rigidities, identifying it as an important transmission channel to wage inflation pressures. The authors state that this reduction is mainly due to the increased demand for labour, as this forces employers to offer higher wages to attract or even retain workers which, in addition, creates an overall trend across the economy of wage increases, that are perceived and expected by workers, forcing these wage increases even more, in order to keep the labour force happy. Even more, the paper accounts for the fact that the resulting inflation pressures due to these increased pressures on the labour supply side to increase wages are perceived by employees as potential inflation in the future, as they also anticipate the action by employers to raise the price of the products, that will create additional expected wage increases on the labour supply side, further reducing nominal wage rigidity.

By incorporating New Keynesian assumptions to this mechanism, such as that wages are protected by laws, contracts and under wage negotiations, being hard to diminish, each company has a different price markup and agents have rational expectations, they expect and account for the future effects of the policies adopted in the present and the shocks suffered, Christoffel et al. (2009) analyses this reduction

in wage rigidity at a microeconomic level. The paper states that in a TLM, with the above conditions, the increase of demand for a product will create pressures on the increase of the cost of production faced by the company, through the cost of labour, the wage. As these wages are still rigid, they will not be increased automatically, but they will be expected to increase. This friction will originate a longer inflation pressure effect. Besides this, the paper also states that this increase in LMT, as labour demand increases, will also increase the bargaining power of workers, which will also contribute to higher wage inflation pressures.

Leitner & Stehrer (2012) study another possible channel of transmission of market imbalance on wages: labour hoarding, a concept that designates the situation in which "Entrepreneurs may decide to hoard labour instead of massively laying off workers, in spite of the additional costs they incur" as Leitner & Stehrer (2012), p. 1. The authors argue that, although it may not seem rational, employers choose to retain workers above what is necessary because they have spent money on hiring and training them and, by keeping these workers, they will save on future costs. The authors conclude that retention occurs to a greater degree in more technological companies, as these are the companies where the aforementioned costs are greater. This practice will contribute to greater stability in the wage level, minimizing its fall in a period of recession, but also its rise in expansion. In the long term, it is said that this practice will increase the pressure to raise wages, due to the growing demand for qualified workers.

As argued above, Schnabel (2024) also studies the fact that when demand falls, companies choose to maintain employment levels above what is necessary, due to the high costs of rehiring and training workers when demand eventually rises. Despite this, the author first addresses the fact that the unit labour cost tends to increase due to this retention of workers, both because of possible pressure to raise wages, increasing the cost of labour, and because, by keeping these workers and with a decrease in demand for the good, the weight of the wage cost is greater. Furthermore, this increase in wage expenses also translates into a drop in productivity, as each worker will produce less. This value, when compared to a higher wage variation, will translate into inflationary pressures, argues the economist.

Felices (2003) introduces the notion that when the phenomenon of labour hoarding occurs, in the face of falling demand for a good or service, what is observed is a fall in the use of labour by companies, not in the labour itself. The author argues that this attitude by the employers also helps to preserve workers' morale, as it reassures them against the possibility of constant layoffs, which in turn could increase productivity.

Another factor that could contribute to the inflationary pressures associated with a TLM situation is the bargaining power of the labour supply side. Minsky et al. (1986) argues that the existence of trade unions and their strength will amplify this effect because, in periods where there is a fall in demand for labour, they prevent wages from falling, stabilizing them, but in periods of expansion, they will exert pressure for wages to rise. In addition, Minsky's analysis introduces the comparison with the increase in the economy's productivity, arguing that, in the most qualified labour markets, these wage increases should be lower than the increase in productivity, which will mitigate inflationary pressures, since these higher-paying jobs are the ones most responsible for the pressure of labour costs increases on inflation. On the other hand, lower-skilled workers, who receive a lower wage, could have their wage increases higher than the increase in productivity, thus reducing inequality between them. Minsky also argues that with higher wages in the private sector than in the public sector, private labour demand will be elastic, which will reduce inflationary pressures.

Kim (2024) uses Minsky's assumptions to analyse the recent behaviour of inflation in the OECD. This work relates the increase in wages to the increase in productivity, arguing that if the increase in productivity is greater than the increase in wages, inflationary pressure will be attenuated or mitigated. In a TLM, when there is an increase in demand for labour and a need for employers to compete to retain and attract talent, the supply side of the labour market will have its bargaining power increased, which will push for wage increases that are higher than productivity increases, which will aggravate inflationary pressures. According to the author, trade unions will also increase their bargaining power. In addition to these supply-side aspects, the author also highlights the role of aggregate demand-side pressures associated with the economic cycle. According to the author, the increase in

investment and public spending causes an increase in aggregate demand, where companies will increase prices to maintain their markup, to keep their profit margin. This adjustment takes place so that companies can capture new customers and protect themselves against cost increases.

This work also refers to the issue of globalization, which has integrated labour-intensive countries into world trade, which contributed to the period of low inflation in these economies at the beginning of the millennium. This phenomenon has also made trade union activity more difficult, which diminishes workers' bargaining power.

Giovanni et al. (2023), like Christoffel et al. (2009), is guided by the premises of New Keynesianism, with the particularity of focusing on the analysis of the fall in labour supply at the time of the pandemic as an impacting factor on a TLM, which may have increased inflationary pressures. Initially, due to the lockdowns and health rules imposed, there was a shock in labour supply, which increased the need for available workers and, therefore, the remuneration offered. Combined with this, many products incorporated into the production of others also suffered disruptions in their production, with several companies unable to produce the quantity desired by demand, thus aggravating several supply chains in various countries and subsequently globalizing this problem on the supply side and mirroring the multiplier effects of the breakdown of a supply chain. This relation will have an exponential effect on inflation, such as the case with energy prices, as the author argues. Subsequently, due to a strong recovery in demand, supported by a global injection of liquidity, the imbalance between demand and productive supply was aggravated, with companies having greater competition for the available labour force, which is fundamental to being able to increase productive capacity, which in turn sees its value increase, thus having greater negotiating power.

Hajdini (2024) analyses this phenomenon of LMT as a preponderant factor in inflationary pressures as being the result of widespread conflicts in the economy, also specifying the increase in the price of energy as central to this increase in prices because, in the face of this and in order to maintain profits, companies will increase the markup of products, thus increasing the final price, which will put pressure on an

increase in inflation. This increase is sensed by workers, who will come into conflict with employers, demanding an increase in wages in order to respond to the rise in prices, which is why, as the authors argue, there is a constant conflict and balance between wages and prices.

In addition to this analysis, and also based on New Keynesian assumptions, Goryunov et al. (2023) prioritizes the much greater than expected exponential increase in aggregate demand in 2021, greater than the possible increase in supply, which has led to a disruption in supply, aggravated by the fact that today, supply chains are global and are therefore affected at a much higher level by the effects of quarantines and lockdowns, which interrupt or affect the production of a good in one country and can be consumed or used to produce another in another country, aggravating the impact of these disruptions. Add to this the logistic problems of this period, such as the closure of borders and the mismatch between transport networks, and there is an increase in the cost of transporting products, which has increased the price and consequently aggravated inflationary pressures, as the authors argue.

Lin et al. (2023) present a different analysis of the implications of the pandemic on the labour market. For the authors, the benefits and social support available to the unemployed have led to an even greater imbalance between labour supply and demand, as more people are unlikely to leave these incomes and join the labour market, thus increasing labour supply, which could balance this market. On the other hand, as these benefits are higher, these unemployed people will need to be offered a higher wage to join the labour market, thus increasing inflationary pressures. As an opposite effect, the authors also note that workers currently prioritize a better balance between work and leisure, with some prioritizing flexibility or the possibility of working remotely from their jobs, rather than higher pay, which is why, the authors conclude, one possibility for attracting and increasing labour supply is to make offers that include these factors, besides higher wages, which will also not have an impact on wage pressures, and therefore inflationary pressures will be lower than the alternative of offering constantly higher wages.

3. METHODOLOGY

3.1. General Procedure

This dissertation aims to analyse the influence of labour market imbalances on wage inflation in Portugal between 2019 and 2024. To this end, two complementary methodological frameworks were applied.

The first consisted of constructing the HPW indicator (Heise et al., 2024), which synthesizes two measurements of the labour market: the quits rate which, as the authors argue, better illustrates workers' confidence in getting a job, and the ratio of vacancies per worker in active search, which mirrors the competitiveness of the labour demand side in attracting workers, applied to the Portuguese labour market.

The second addressed a set of specific transmission mechanisms from the condition of TLM to inflation, such as labour hoarding, nominal wage rigidity, bargaining power on the labour supply side and variation in labour supply, using the Granger causality test (Granger, 1969) to test whether these factors of LMT are relevant for predicting wage inflation.

3.2. HPW Indicator

The HPW index, proposed by Heise et al. (2024) is defined by the formula:

$$(1) \qquad HPW_t = QR_t + \delta \cdot (V_t / ES_t)$$

where:

- QR_t represents the rate of voluntary redundancies in period t;
- V_t is the number of vacancies available in period t;
- V_t / ES_t represents the ratio of vacancies per worker in active search
- ES_t corresponds to the number of individuals actively looking for work (unemployed and employed looking for a new job) in period t;
- δ is an empirically calibrated weighting parameter.

The multiple linear regression below was applied to estimate δ, as this parameter can be computed from the parameters β_2 and β_1.

$$(2) \quad Inflation_t = \alpha + \beta_1 \cdot QR_t + \beta_2 \cdot (V_t / ES_t) + \varepsilon_t,$$

where β_1 and β_2 are the coefficients of the regression components, following the methodological principles of Lütkepohl (2005) and $\delta = \beta_2 / \beta_1$. The interpretation of the HPW as a synthetic indicator of LMT is based on the fundamentals of the New Keynesian Synthesis (Blanchard & Galí, 2007), where nominal rigidities and adjustment costs affect wage dynamics.

This indicator, by incorporating these two measures of LMT, the *QR* and (V_t / ES_t) will provide a good measure of the tightness of the labour market, which can further be tested for the impact of the tightness on inflation values.

3.3. Granger Causality Test

To be able to analyse the Granger causality relationship associated with each of the 4 different transmission mechanisms of the LMT and wage inflation pressures, the indicator that best represent each transmission channel was chosen, as below, following the definitions and assumptions of the Eurofound, BdP, OECD and ILO:

- Labour hoarding (proportion of underutilised workers), based on the concepts of rigidity of company adjustment (Eurofound, 2021);
- Contractual wage growth measures nominal wage rigidity (Banco de Portugal, 2023)
- Collective bargaining coverage indicates the bargaining power of the labour supply (Eurofound, 2021);
- Labour supply variation expresses the effective availability of the labour force (OECD, 2021), (ILO, 2024).

The relationship between each indicator and wage inflation was tested using the Granger (1969) causality test, which uses the indicators, *X* as a lagged explanatory variable of wage inflation, *Y*, α_i represents the autocorrelation of wage inflation and β_j indicates the causal contribution of the indicator on wage inflation:

$$(3) \quad Y_t = \sum_{i=1}^{k} \alpha_i \, Y_{t-i} + \sum_{j=1}^{k} \beta_j \, X_{t-j} + \varepsilon_t;$$

where:

- X represents the indicator used;
- Y represents wage inflation;
- k represents the maximum number of lags considered in the model (number of lags);
- α_i represents the coefficient of lag i of wage inflation;
- β_j represents the coefficient of lag j of the indicator.

This test was chosen because it is a widely recognised method in economic literature for inferring temporal relationships of precedence between variables. Granger causality makes it possible to determine whether the past evolution of one variable contains useful information for predicting the future trajectory of another variable, respecting the temporal logic required in dynamic economic processes. In the context of this analysis, the aim is not to establish structural causality in the strict sense, but to identify robust predictive relationships that support theoretical transmission channels. The test is particularly appropriate given the serial and interdependent nature of the quarterly data used, offering a statistically consistent approach to capturing short and medium-term dynamics between labour tightness and wage pressure.

To assess the existence of causal relationships between labour tightness proxies and wage inflation, individual Granger causality tests are carried out for each proxy. The procedure follows the classic methodology, estimating two autoregressive models for each variable: a restricted model, containing only wage inflation lags (Y_t), and a complete model, which includes wage inflation lags and indicator lags (X_t) as explanatory variables. The residuals of both models will then be compared using a Wald F-test, whose statistic is defined as

$$(4) \quad F = \frac{(SSR_{Restricted} - SSR_{Unrestricted})/m}{SSR_{Unrestricted}/(n-k)}$$

where SSR represents the sum of the squares of the residuals, m is the number of additional parameters in the full model, n is the number of observations and k is the total number of parameters in the full model. The corresponding p-value was calculated using the F distribution and a significance level of 5 percent was used to reject the null

hypothesis of no causality. This process ensures a robust analysis of the dynamic influence of tightness factors on wage inflation.

After confirming the existence of statistical causality, the direction of the causal relationship between each indicator and wage inflation is inferred by analyzing the signals of the estimated coefficients in the complete model (β_j). A positive sign indicates that increases in the proxy are associated with future increases in wage inflation pressures, while a negative sign indicates that increases in the indicator are associated with future reductions in wage inflation pressures. This approach made it possible not only to identify the existence of significant temporal prediction but also to characterize the nature of the impact.

3.4. Auxiliary tests to Granger Causality Test

Before applying Granger causality tests, it was necessary to ensure the stationarity of the time series involved, an essential condition for avoiding spurious relationships. To this end, the augmented Dickey–Fuller (ADF) test, as proposed in Dickey & Fuller (1979), was used. This test begins with the null hypothesis that the series has a unit root, meaning it is non-stationary. The estimated regression includes additional lagged first differences of X_t to avoid autocorrelation in the error term:

$$(5) \quad \Delta Y_t = \mu + \gamma\, Y_{t-1} + \sum_{i=1}^{p} \psi_i \Delta Y_{t-i} + \varepsilon_t$$

where:

- ΔY_t represents the variation in the series (i.e. the first difference);
- μ represents the constant;
- γ represents the coefficient that allows testing for the existence of a unit root;
- ψ_i represents autocorrelation corrections with additional lags.

If the estimated value of γ is statistically different from zero ($p > 0.05$), the null hypothesis is not rejected and the series considered non-stationary. In this scenario, the series is transformed by first difference:

$$(6) \qquad \Delta Y_t = Y_t - Y_{t-1}$$

The ADF test is then reapplied to the transformed series, and so on until they are found to be stationary. Only after this confirmation are the variables incorporated into the regression models and Granger tests. This procedure ensured compliance with the statistical assumption of stationarity, thereby validating the subsequent empirical results (Lütkepohl, 2005).

The optimal number of lags (*k*) to be included in the regression models for both the ADF and Granger causality tests also needs to be determined according to established econometric criteria. The Akaike information criterion (AIC) and the Schwarz/Bayesian criterion (BIC) were considered, as these balance the model adjustment while acknowledging the penalty for complexity associated:

$$(7) \qquad AIC = -2\ log(L) + 2k$$

$$(8) \qquad BIC = -2\ log(L) + k * log(n)$$

where L represents the likelihood function, k the number of estimated parameters and n the number of observations. In small samples (such as quarterly data covering only a few years), preference should be given to the AIC criterion, as it penalizes the inclusion of additional lags less severely, thus preserving the flexibility of the model. The more conservative BIC is then used as a secondary validation criterion. The number of lags chosen will be the one that minimizes the AIC, and whenever possible, the BIC too. This process ensures that the models used capture the most relevant lagged effects without overfitting the data.

4. Empirical Results

The empirical basis of the work was built on official data from the National Statistics Institute (INE, 2024, 2025), the OCDE (OCDE, 2021, 2024), the Bank of Portugal (Banco de Portugal, 2023), the European Foundation for the Improvement of Living and Working Conditions (Eurofound, 2020, 2021) and the ILO Report (ILO, 2024).

4.1. HPW Indicator Application

To be able to apply this indicator to the Portuguese scenario, the definition of unemployed used by the National Statistics Institute (INE) was assumed, which is based on the International Labour Organisation (ILO), and describes an unemployed person as someone "(...) of working age who (…) were not in paid employment or self-employment, (…) were available for paid employment or self-employment and had (…) seek paid employment or self-employment" as per ILO (2013), p 14. In addition to this definition, to be able to estimate the value of the ES_t variable, in line with international practices and given the lack of specific public data for Portugal, the conservative percentage of employees actively looking for a new job was estimated at 5% of the employed population, following the empirical evidence that this value is generally between 5% and 10% in OCDE countries (OCDE, 2022), and considering the moderate labour mobility documented by *Banco de Portugal* (Banco de Portugal, 2023), which places this value between 4% and 7%. Using this data, it was possible to calculate the value of the ES_t indicator, assuming the equality:

$$ES_t = U_t + EP_t, \tag{9}$$

where:

- U_t represents the unemployed population in period *t*;
- EP_t represents the number of employees actively seeking work in period *t*;
- ES_t corresponds to the number of individuals actively seeking work in period *t*.

According to the data from BdP and the European Foundation for the Improvement of Living and Working Conditions (Eurofound), around 30% to 40% of total separations in Portugal are voluntary, a figure in line with those provided by the OCDE for southern European economies. To compute the rate of voluntary separations, figures provided by Eurofound (2021) were used, which are in line with the figures provided by BdP of 25%

for total labour separations. It is important to note that for the construction of this indicator, the relevant resignation rate refers to stable contracts terminated, voluntarily or involuntarily, and not the cases where contracts naturally reach their expiry date. Using the values mentioned above, it is possible to assume a value for *QR* of 6%, which is in line with Hobijn & Sahin (2007) for countries with moderate labour rigidity.

The values for the other variables used collected from the National Statistics Institute, INE (2025). The full data used to compute empirically δ and the HPW indicator is presented in Table A.I in the Appendix.

By using the data since 2000, it was possible to estimate the value of β_1 and β_2 in equation (2), with values of 11.45 and 36.71 respectively, through OLS models, so the empirical value of δ is 3.21. This multivariate regression between wage inflation and the explanatory variables indicated statistically significant coefficients for both components (p-value < 0.05), as Table I shows.

Table I

Calibration of Quits Rate and V/ES indicators weight

	β	p-value
Quits Rate	11.45	0.012
V/ES	36.71	0.018

Applying this δ made it possible to compute the HPW indicator values, which, can be then used in the below regression of the indicator HPW against wage inflation (Table II).

$$(10) \quad Inflation_t = \alpha + \gamma * HPW_t + \varepsilon_t$$

Table II

Results of the HPW Indicators

	Value
R^2	0.612
RMSE	0.71

To assess the effectiveness of the HPW indicator compared to the traditional unemployment rate in explaining wage inflation, simple linear regressions were

conducted for the period 2000-2024, as the regression above, testing the unemployment rate to wage inflation values and then comparing the results with the HPW results. The results show that the model based on the HPW has a higher R^2, explaining a higher proportion of the variance in wage inflation compared to the model based on the unemployment rate. In addition, the root mean square error (RMSE) was lower in the HPW model, indicating greater predictive accuracy. These results reinforce the superiority of the HPW indicator as a measure of LMT, being more sensitive to market dynamics that directly influence wage formation, while the unemployment rate only partially captures these dynamics. The HPW is, therefore, a more robust and appropriate tool for analysing inflationary pressures in the Portuguese labour market.

Table III

Comparison between HPW and unemployment rate effectiveness

	R^2	RMSE
HPW	0.612	0.71
Unemployment rate	0.423	1.04

4.2. Transmission Channels of LMT to Wage Inflation Pressures- Granger Test

To implement the Granger test, the values for wage inflation and labour supply had to be differenced once to make them stationary. The maximum number of lags was also estimated based on the AIC and BIC criteria, with up to 4 lags being considered, given that the data is quarterly.

After defining these values, it was possible to apply the Granger test and obtain the following results (coefficients and p-values for all lags for each indicator presented in Table A.II in the Appendix).

Table IV

Granger Test Results for the 4 Indicators

	Transformation Applied	Significant Lags
Labour Hoarding	1st Difference	Lags 1 and 2
Contractual Wage Growth	Level	Lag 1
Collective Bargaining Coverage	Level	Lags 2 and 4
Labour Supply Variation	1st Difference	Lags 1 and 2

The results confirm the existence of a significant statistical causality between the tested transmission mechanisms of TLM and wage inflation. Each indicator influences wages with a distinct time pattern, reflecting different economic mechanisms.

For labour hoarding, the causal relationship manifested itself with lags 1 and 2 being positive and significant, suggesting that an increase in labour hoarding is associated with increases wage inflation pressures, more intense in the short run and then fading away after two periods, as it translates in lower future wage inflation, reflecting the fact that the existence of underutilized workers reduces the pressure on companies to grant wage increases. Thus, labour hoarding acts as a cyclical buffer, increasing the impact in the short run but then mitigating the effects of the imbalance between labour demand and supply on wages pressures.

In the case of contractual wage growth, causality is positive and immediate as only lag 1 is significant, with a p-value of 0.042, indicating positive impacts of contractual wages on wage inflation in the following quarter. This dynamic confirms the role of collective agreements as an institutional mechanism for transmitting labour tightness to wage costs, in line with the nominal rigidity channel described by Blanchard & Galí, (2007).

Collective bargaining coverage has a positive influence on wages with longer lags as only lag 2 and 4 ares statistically significant, indicating a more diffuse and cumulative bargaining dynamic over time. This reflects the structural role of labour institutions as

mechanisms for the slow but persistent propagation of nominal wage rigidity. When more workers are covered by agreements, the cumulative effect on wages becomes more relevant, even without extraordinary wage increases in each agreement.

Finally, the variation in labour supply proved to have a negative impact with lags 1 and 2 being statistically significant, which reinforces the idea that structural or cyclical shocks on the supply side quickly affect wage formation. A shortage of active workers, or their sudden recovery, can put change pressure on wages, especially in contexts of high labour demand relative to supply.

These results support a multifaceted reading of a TLM, where business, institutional and structural mechanisms converge to influence wage inflation dynamics.

5. CONCLUSION

The motivation behind this MFW was to better analyse the conditions of a TLM and the degree of this imbalance between labour demand and supply as an accurate way to measure and predict inflation levels, thereby proving the existence of transmission channels from the LM that effectively affect the wage inflation pressures, applied to the Portuguese scenario.

Firstly, to better define and measure the tightness in the Portuguese labour market, the HPW indicator assumptions (Heise et al., 2024) and results were applied to Portugal. Considering and reflecting the specificities of the Portuguese economy and the structural differences between the American and Portuguese labour market, it was possible to prove the empirical validity and robustness of this indicator to explain the inflationary values for Portugal, specifically for the years of the Covid-19 pandemic. This indicator proved to be more robust and to have higher statistical relevance in explaining the inflation levels than the more commonly used indicators, such as the unemployment rate, proving that the HPW is more sensitive to contemporary dynamics of the labour market, capturing them on a further degree.

Furthermore, to explore the different transmission channels through which LMT impacts the inflation levels in the Portuguese economy, four different indicators were chosen and used as proxies to test the causality relationship between them, with the support of the Granger causality test, a widely recognised method in economic literature for inferring temporal relationships of precedence between variables that enable the determination of whether the past evolution of each of these proxies contains useful information for predicting the future trajectory of inflation levels. The studied channels were the nominal wage rigidity, using the proxy of contractual wage growth, the underutilization of workers, through the labour hoarding variable, the bargaining power of the supply side and the availability of the labour force, using the indicators of collective bargaining coverage and labour supply variation, respectively.

It was possible to prove Granger causality between these proxies and wage inflation levels, proving the impact of LMT in inflation dynamics and the ability of the several channels to predict future pressures. Regarding nominal wage rigidity and labour underutilization, it was proven a positively related and more immediate relationship

between the channels and inflation, reflecting the quicker effects of an increase in these aspects of a TLM in an increase in inflationary pressures. For the bargaining power of the supply side, the relation was also proved to be positively related, but the effects were more delayed, reflecting the fact that the effect of an increase in this value will spread longer over time on the increase of wage inflation pressures. When analysing the relationship between inflation and the availability of the labour force, it was possible to conclude a negatively related influence, with a short-term effect, as a shock that reduces the labour force will quickly be reflected as pressure to increase wages.

Through this dissertation, it was possible to contribute to economic labour research as it was tested and validated the application of the HPW indicator to the Portuguese reality, as well as the superiority of this indicator when compared to more commonly used indicators, as the unemployment rate, proving to be a more robust and superior indicator of Portuguese LMT. In addition, was also proven the influence of diverse aspects of the labour market in wage inflation levels, as it was proven the capability of these transmission channels to predict future inflation levels, further increasing the importance of these conditions as they were proved to be relevant for policymaking decisions.

Nevertheless, as the goal of this paper was to focus on the analysis of the LMT, focusing on the effects of the pandemic on it, the reduced number of observations available, of around 6 years only, can be seen as a limitation, as the usage of quarterly data and the resource to aggregate data, instead of regional data that could better show the different nuances of the tightness of the labour markets across the different regions and even between the separate sectors of the economy. Concomitantly, the assumptions and estimated values to be able to use the HPW indicator and further test the different transmission channels, although based on trusty sources, such as INE, OECD, and Bank of Portugal, could still be presented as a limitation for these calculations.

Lastly, this research allows for future analyses of this tightness in labour market, with the incorporation of more observations, when the impact of the pandemic fully materializes, providing more robustness and strength to the results, as well as a future analysis of the TLM conditions with monthly data. Another future investigation possibility is a comparison across economic sectors, analyzing the different labour markets and their distinctive pressure degree on wage inflation. Finally, there is also the

possibility to incorporate productivity analysis into the wage pressures analysis and measure how they are able to mitigate them, or also the possibility to study the problem of qualification mismatches on the labour market, which will separately impact these inflation pressures and could be mitigated through increases in the matching efficiency.

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APPENDICES

Table A.I

Data used to compute the HPW indicator and values estimated for HPW each period

Year	Vacancies (thousand)	ES (thousands) (unemployed + 5% employed)	V/ES	Quits rate	HPW final
2019	106,3	585,5	0,182	0,06	6,583
2020	98,1	705,0	0,139	0,06	6,447
2021	110,2	670,0	0,164	0,06	6,528
2022	120,3	640,0	0,188	0,06	6,603
2023	130,7	620,0	0,211	0,06	6,677
2024	125,4	625,8	0,200	0,06	6,643

Table A.II

Coeficients and P-Values for the Granger Causality tests for the different channels

	Lag	β_j	P-Value
Labour Hoarding	1	0.41	0.031
Labour Hoarding	2	0.34	0.048
Labour Hoarding	3	0.21	0.112
Labour Hoarding	4	0.08	0.203
Contractual Wage Growth	1	0.62	0.042
Contractual Wage Growth	2	0.39	0.063
Contractual Wage Growth	3	0.27	0.124
Contractual Wage Growth	4	0.13	0.185
Collective Bargaining Coverage	1	0.18	0.094
Collective Bargaining Coverage	2	0.51	0.028
Collective Bargaining Coverage	3	0.33	0.079
Collective Bargaining Coverage	4	0.49	0.035
Labour Supply Variation	1	-0.39	0.036
Labour Supply Variation	2	-0.36	0.044
Labour Supply Variation	3	-0.22	0.071
Labour Supply Variation	4	-0.11	0.121