PRODUCTIVITY, PAY, AND TRADE:

THE EFFECT OF ECONOMIC OPENNESS ON THE RETURNS TO PRODUCTIVITY

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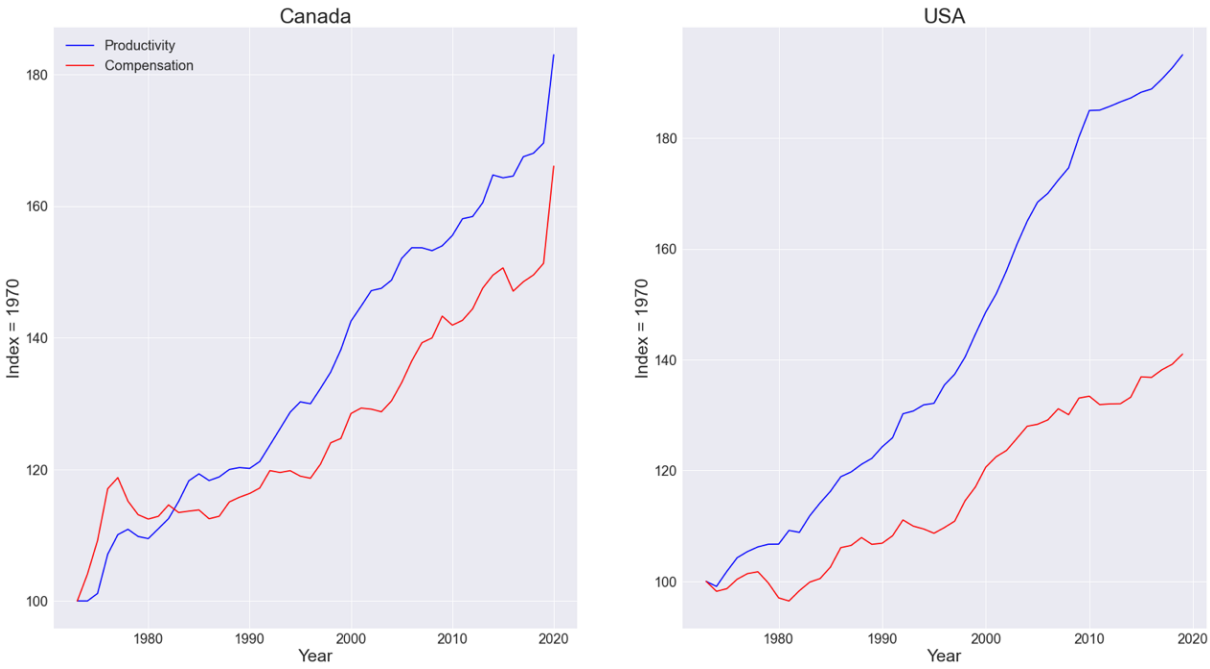
Abstract

Economists have recently become concerned with the weakening link between increases in productivity and increases in pay, particularly because there is unexplained variation between countries' strength of relationships. I study the effect of openness on the delinkage of the pay-productivity relationship in 35 OECD countries over 50 years and find that incremental increases in real productivity growth led to smaller increases in real compensation in economies which were more open. This suggests that comparisons between investments which seek to increase compensation through productivity may not be as effective in more open economies. This is particularly important as a disproportionate amount of research is conducted in the US, the country which is the most closed among the 35 OECD countries in the dataset.

Introduction

Labour productivity has traditionally been seen as the means to increase compensation and has grown consistently over the last century. Economists have thus become increasingly concerned with stalling real wages despite consistent increases in productivity. Economic theory suggests that increases in labour's real productivity should bring about an equivalent increase in labour's compensation, this relationship has historically held for countries such as the US (Stansbury and Summers 2019). However, evidence from Greenspon et al (2021) suggests that this relationship has degraded over time. These results have been replicated in a variety of countries, including in Canada (Williams 2021). Examining the relationship between productivity and pay in *Figure 1*, the gap is apparent, however it is not clear what factors are driving this trend, and to what degree it is caused by factors exogenous to productivity from the graph alone.

Figure 1: Productivity and Compensation in Canada and the US



Greenspon et al (2021) use the Can-American comparison to argue that the increased gap in the US is attributed to factors exogenous to productivity, while Canada has experienced a significantly larger breakdown in the relationship between productivity and pay. In their analysis the authors note that Canada is significantly more economically open than the US. This raises the question, does economic openness play a role in productivity's returns to compensation?

Previously Schwellnus et al (2017) and Stansbury and Summers (2019) establish the existence of delinkage in a set of OECD countries, suggesting the breakdown has been experienced in a large variety of countries, but neither study analyzes openness.

I compare data from 35 OECD countries over the span of 50 years to study the effect of openness on the link between productivity and compensation (also called linkage) and find that there is a strong negative association between an economy's openness and its returns to productivity. To identify this relationship, I utilize OLS regression to identify the relationship between compensation and productivity conditional on openness by using an interaction term.

This result has policy implications, policymakers face consistent pressure to improve the real compensation of labour, one route to achieve this has traditionally been investing in programs which improve labour's real productivity. While there is still a positive effect, my research suggests it may not be appropriate to use comparison statistics in a cost benefit analysis when using data from a more closed economy.

This paper also contributes to the literature surrounding explanations of why the transmission from productivity to pay is weakening. Authors have hypothesized that slackening increases in real wages when compared to steadily increasing productivity measures may be due to commodity export dependence in open economies like Canada (Williams 2021). My evidence suggests that theories explaining delinkage must explain why

an association between openness and delinkage exists, possibly granting some merit to explanations such as Williams'.

Literature Review

The productivity-pay literature specifically emphasizes the meaning of different measurements when interpreting empirical results. There is a distinction between the productivity-pay link with respect to average wages and typical wages. As documented by Green et al (2017), large increases in wealth inequality have caused typical wages and average wages to diverge. Typical compensation is more important for analyzing living standards (Bivens and Mishel 2015) while average compensation captures the total amount to amount to be distributed to labour (Lawrence 2016).

Typical worker compensation has been largely analyzed using median worker compensation and production/nonsupervisory income[1], and most recent papers have chosen to examine both when data is available (Bivens and Mishel 2015, Stansbury and Summers 2019, Williams 2021, Greenspon et al 2021). In the US, Stansbury and Summers (2019) find that estimates for production/non-supervisory income are lower. There has, however, been criticism that production/non-supervisory income does not capture the intended metric. In American measurements it can be interpreted to exclude salaried non-supervisory compensation, therefore leaving out a large portion of the workforce (Kurmann and Stewart 2015). Research using this metric suggests that workers receiving wages have a weaker pay-productivity link than to salaried workers (Greenspon et al 2021). The results presented in this paper utilize average income, so it is important to note that the relationship presented will likely by stronger than it would be for lower incomes and wage-paid workers.

[1] Production/non-supervisory income measures the income of people involved in physical production processes but not in supervisory positions such as fabricating, repairing, assembling, etc.

Within the literature surrounding productivity-pay decoupling, there is also an important question regarding which deflator to use. Feldstein (2008) poses that PPI (producer price inflator) is a better choice to analyze the relationship with respect to factor income, as it captures the cost to firms better. However, the CPI is more commonly used because it better captures changes in living costs by capturing changing costs faced by consumers (Bivens and Mishel 2015, Stansbury and Summers 2019, Greenspon et al 2021, Williams 2021). Lawrence (2016) argues that, as an alternative to CPI, PCE ought to be used because establishment surveys likely contain less measurement error. Unfortunately, the PCE is only available in the US data and cannot be used for cross-country comparison.

Stansbury and Summers (2019) note, it is important to compare PPI and CPI to understand how the terms of trade change over time. This is particularly true when prices are not determined domestically, as is often the case in small open economies like Canada, in which case productivity growth can improve solely due to terms of trade improvements. Arsenault et al (2008) show that Canadian labour's terms of trade improvements prevented typical median income from falling between 1961-2007, and more recently Williams (2021) shows that terms of trade have remained stagnant since 2008 bringing cause for concern about future median compensation. Although not available through the OECD, future work can expand upon this study by incorporating a wider range of deflators as I only use CPI.

Data Summary

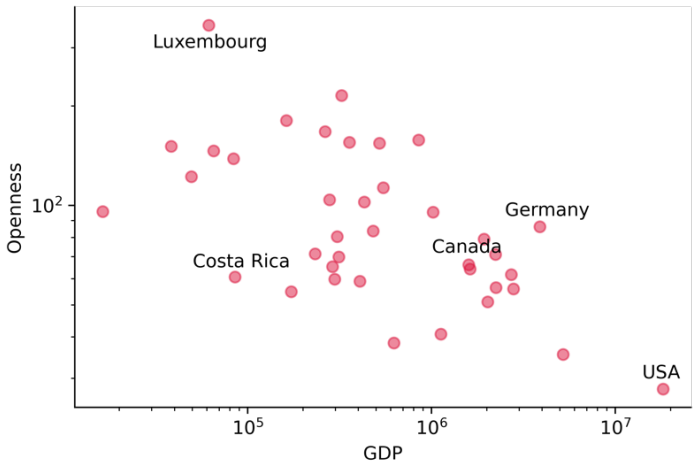
I utilise panel data from the OECD public database. Specifically, I use exports, imports, GDP, real labour productivity, average nominal compensation per labour hour, CPI, and unemployment. Data is reported at the country and year level. Among this data there are 868 observations divided among 35 countries in 5 major regions (North America, Europe,

Asia, South America, and Oceania) with the earliest data coming from 1970. Countries began collecting data in different years, the average number of observations per country is 24.8, however Canada and America both have 49 observations, and the number is generally biased to be higher for western countries. This suggests that the dataset will produce results that better reflect western economies and better reflect more recent relationships if there does exist a different relationship over time and location.

The OECD measures labour compensation per hour as compensation of employees in national currency divided by hours of work. Labour productivity is measured by growth in GDP per hour worked and is measured in real terms. Both CPI and labour productivity are indexed to 100 in 2015.

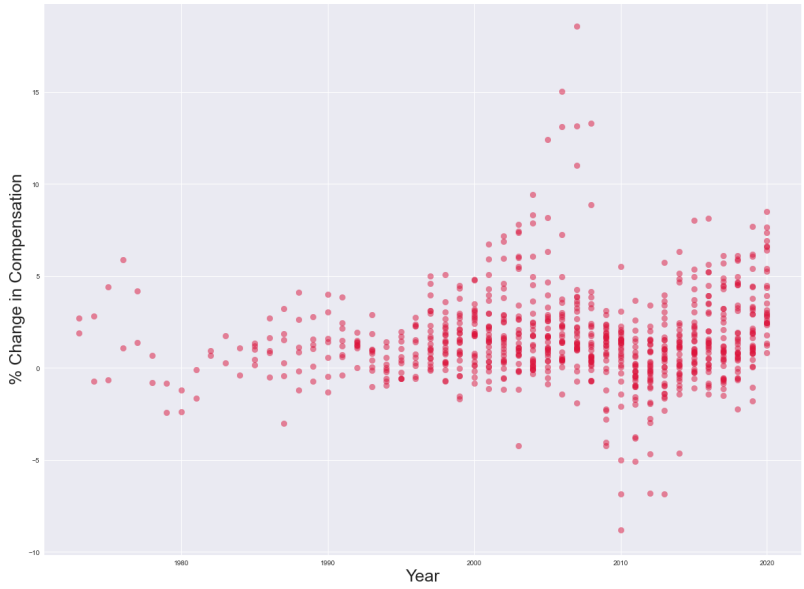
It is important to ensure sufficient variation in the data between openness and size in order to identify the effect of openness independent from the tendency of small economies to be more open due to a decreased ability to produce enough variations of goods internally. *Figure 2* displays size against openness in log scale. Notably, there is significant variation with countries such as Costa Rica being relatively closed and small while Germany represents a large country that is relatively open for its size.

Figure 2: Openness vs Size



I also plot change in compensation to ensure that there is enough variation in the change in compensation for accurate estimation, as well as to identify any trends. There exist a set of values around the 2008 financial crisis which may systematically differ. Most of these values come from Latvia and Greece and occur between 2007 and 2012. I address the issue with Latvia in the analysis of errors in the appendix, but it does not impact the conclusion of the paper.

Figure 3: Variation in Change of Compensation



Data Transformations

In this study I construct a measure of openness defined by exports plus imports divided by GDP. This is intended to measure how frequently a country trades, and therefore how affected they are by changes in their terms of trade.

When measuring compensation and GDP I deflate the OECD statistic with the CPI for that country-year pair to measure all variables in real terms. Since CPI and compensation are both indexed to 100 at 2015, compensation remains indexed to 2015.

To allow for wages to adjust to productivity, I construct a variable for the two-year moving average of productivity change. Additionally, to capture the lasting effect of labour market conditions I construct a two year moving average of unemployment. Data transormations are listed in equation form in the appendex.

Table 1: Average GDP growth per decade

Year	1970-80	1980-90	1990-20000	2000-10	2010-20
Average Growth	2.92%	2.34%	2.27%	2.03%	1.47%

Note: Numbers calculated from GDP/CPI year on year growth then averaged within the dataset.

In *Table 1* I present the average GDP growth per decade, which shows that growth is slowing down over time. This is important to note, as it suggests that the weakening of the relationship between pay and productivity could be connected to slowing growth.

An alternate hypothesis to openness degrading the relationship between productivity and pay is that lowing GDP growth is instead creating market conditions where pay increases are less common for employees. This hypothesis is not easily testable as both growth slowdowns and decreases in the pay productivity link are highly correlated with time and the effect of slowing productivity will come with many possible confounders.

Empirical Strategy

To find the effect of openness in linkage, I examine the degree to which changes in percent productivity change is associated with percent compensation changes dependent on the level of openness. For a single country we can view a cross-section of the relationship in *Figure 4* below.

Figure 4: Productivity change and Compensation change in Canada

I measure this relationship for all countries in an OLS equation, allowing the relationship to vary based on the level of openness a country has. The variable measurement can be viewed the transformations in the data section. I account for sticky wages by using a two-year rolling average of percent change in compensation and productivity.

For controls, I utilise unemployment both as a control for the labour market and as a control for economic conditions. Unemployment as a labour market control has two effects on the relationship: increases in unemployment are associated with both reductions in compensation through increased job competition, and improvements in productivity as the least productive workers are more likely to be laid off first. I also use unemployment as a measure of the business cycle as economic downturn is associated with increased unemployment. I include a lagged unemployment variable to account for the persistence of labour market conditions.

In addition, I include a control for openness which may be associated with a wedge between pay and productivity that is exogenous to changes in productivity. Finally, I control for decade and country fixed effects. Thus, the estimation equation takes the following form:

$$Compensation_{it} = \alpha + \beta(Productivity_{it} + Openness_{it}) + \gamma_1 Productivity_{it} + \gamma_2 Country_i + \gamma_3 Openness_{it} + \gamma_4 Decade_t + \gamma_5 Unemployment_{it} + \gamma_6 Unemployment_{it-1} + \epsilon_{it}$$

I define compensation and productivity as the log change variables which allows for a clearly interpretable result: the coefficient β can be read directly as the change in linkage for each percent of GDP that a country imports or exports. This coefficient is not necessarily causal a since I do not isolate the onset of any trade policy, and therefore there could be a third effect correlated with economic openness. Despite this, the coefficient does provide strong evidence for a causal relationship because this data controls for most of the large effects that could be confounding and contains large amounts of variation across countries and over time.

Results

As shown in *Table 2*, the results show a negative effect of -.0022 at the 1% level of significance level. In other words, for each unit of openness, there is an association of a 0.22% smaller linkage effect. When comparing the US and Canada, this metric would predict a gap of about 8.5% greater delinkage in Canada, which is a result within a reasonable range of what Greenspon et al (2021) finds in their comparison.

Table 2: Regression Results on Compensation

Parameter	Estimation	Std. Error	Confidence Interval
Interaction Term	-.0022***	(0.0008)	[-.0038, .0006]
Productivity	.8441***	(.1237)	[.6012, 1.0870]
Openness	-.0112	(.0096)	[-.0300, .0076]
Unemployment	-.7186***	(.1678)	[-1.0479, -.3839]
Lag Unemployment	.3667***	(2.7919)	[.1089, .6245]

Note: Productivity refers to the 2-year rolling average of change in real productivity, and the Interaction Term refers to the interaction between Productivity and Openness measured in imports plus exports as a percentage of total GDP. Unemployment refers to the 2-year rolling average of unemployment rates and Lag Unemployment is the Unemployment value from the last period.

To validate these results, I perform some robustness checks. First, I check whether the results are robust to different lag periods and find that the relationship is statistically the same except in the case of no lag period. A table containing the results can be found in the appendix. It should be noted that the 4-year rolling average specification is only significant at the 10% level. This is due to the loss in statistical power when adding increased roll times, since using a 4-year rolling average period requires ignoring 69 additional entries. The 1-year lag time does not return a statistically significant result, however it suffers from relying on increases in productivity increasing wages immediately which does not account for sticky wages.

I also check a range of control specifications and find that only in the case of no unemployment controls is the coefficient of interest not significant. This is not concerning because as discussed above, unemployment poses a large problem to identification when not included and at least some control for unemployment is necessary.

Table 4*:* Varying Controls on Compensation

Variables	Estimation				
Interaction	-.0022***	-.0022***	-.0020***	-.0013	-.0021***
	(.0008)	(.0008)	(.0009)	(.0013)	(.0009)
Productivity	.8441***	.8441***	.8680***	.7600***	.8272***
	(1.237)	(1.238)	(.1305)	(.1623)	(.1295)
Openness	-.01122	-.0113	-.0021	-.0016	-.0081
	.0096	(.0097)	(.007)	(.0072)	(.0075)
Size Effects	No	Yes	No	No	No
Decade Effects	Yes	Yes	Yes	Yes	No
Unemployment	Yes	Yes	Yes	No	Yes
Lag Unemployment	Yes	Yes	No	No	Yes

Note: Productivity refers to the 2-year rolling average of change in real productivity, and the Interaction Term refers to the interaction between Productivity and Openness measured in imports plus exports as a percentage of total GDP. Unemployment refers to the 2-year rolling average of unemployment rates and Lag Unemployment is the Unemployment value from the last period.

I provide an analysis of errors for the primary estimation model in the appendix. I conclude that removing outliers with high leverage or with high residuals does not impact the findings. Interestingly, almost all high residuals can be accounted for by Latvia from 2007-2012 where compensation fluctuated by high amounts. The model performs best when the economy is experiencing between 0 to 5% changes in compensation.

To further check robustness, future work can expand upon this by testing alternative datasets which measure typical compensation, and by obtaining data for different deflators which are not reported by the OECD. These results presented in this paper are specific to market democracies within the OECD, with most observations from western economies. This relationship may not be externalizable to countries which do not resemble a market democracy. Specifically, there is a lack of data for China, India, and the Middle East.

Conclusion

Differences between the pay-productivity link can be partially explained by economic openness. Countries which are more open are associated with a lower link between pay and productivity. This trend does bring some cause for alarm. If the relationship should prove causal, the consistent increases in economic openness observed may degrade the primary driver of pay increases. There is no reason to believe these trends will not continue unless there is a concerted effort made to reduce these trends. This is true regardless of whether the cause is a third factor such as an association between reliance on commodity exports, or an association between openness and a specific economic organisation. Generally, economies which are the most open may need to explore other avenues to combat stagnating wages or attempt to find a method to strengthen this link. More closed economies can rely more upon productivity growth to raise compensation.

Building upon this, future work should explore possible explanations to better understand what measures can help re-establish this relationship. There is some hope that in the restructuring period after covid this relationship may change, however this is hard to say without understanding the cause of the degrading link. Future work may want to examine this link in the post-covid period to analyze the effects of new economic conditions on linkage.

Given the bias towards western market democracies, it is also important that future study of this topic be expanded to include less easily accessible data where wages are experiencing different trends. Places such as China, India, Africa, larger amounts of South America, and the Middle East all contain economies organised in different ways from those represented in the current dataset. This may provide insights into the nature of the problem and possible solutions.

Moving forward highly open economies must make a concerted effort to search for solutions or reconcile the fact that future efforts to raise compensation through productivity will no longer be as impactful as they continue to expand their relationship with global trade.

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Appendix

Data Transformation Equations:

$$Producitivity_{it} = \frac{1}{2}\Sigma_{t-1}^{t} \log(\Delta\, RealProductivity_{it})$$

$$Compensation_{it} = \frac{1}{2}\,\Sigma_{t-1}^{t} \log\,(\Delta \frac{NominalCompensation_{it}}{CPI_{it}})$$

$$Unemployment_{it} = \frac{1}{2}\Sigma_{t-1}^{t}(Unemployment_{it})$$

$$Openness_{it} = \frac{(Imports_{it} + Exports_{it})}{GDP_{it}}$$

Estimation Equation:

$$Compensation_{it}$$

$$= \alpha + \beta(Productivity_{it} + Openness_{it}) + \gamma_1 Productivity_{it} + \gamma_2 Country_i$$

$$+ \gamma_3 Openness_{it} + \gamma_4 Decade_t + \gamma_5 Unemployment_{it}$$

$$+ \gamma_6 Unemployment_{it-1} + \epsilon_{it}$$

Alternative Rolling Average Results:

Appendix Table 1: Alternative Rolling Averages

Variables	Compensation			
Interaction	-.0017*	-.0022***	-.0025**	-.0025*
	(.0009)	(.0008)	(.0011)	(.0013)
Productivity	.7565***	.8441***	.9394***	.9936***
	(.1176)	(.1237)	(.1611)	(1936)
Openness	-.0046	-.0112	-.0136	-.0144
	(.0078)	(.0096)	(.0101)	(.0091)
Observations	868	833	798	764
Rolling Period	1	2	3	4

Note: Productivity refers to the 2-year rolling average of change in real productivity, and the Interaction Term refers to the interaction between Productivity and Openness measured in imports plus exports as a percentage of total GDP. Unemployment refers to the 2-year rolling average of unemployment rates and Lag Unemployment is the Unemployment value from the last period.

Analysis of Residuals:

Examining the residual plot below, it appears the model may have a weak tendency to overestimate small values, but this is likely due to outliers. Generally, the errors appear to be homoscedastic. The model best predicts fitted values which are between 0 and 5, which is likely more important than other predictions as this is where the economy operates during normal times (rarely does real compensation fall in aggregate save for bad recessions or global anomalies like covid).

Appendix figure 1: Residual plot from primary estimation model

Examining the squared residuals, 6 of the top 10 residuals are from Latvia. Considering this possible outlier I performed the regression after removing Latvia. The coefficient does not significantly change, and the p-value increases to just above 1%, likely due to the loss of observations.

Similarly, I checked the regression removing the United States, a country which has high leverage due to its high openness, however this impacts the results identically to Latvia, reducing statistical power slightly and no significant change on the interaction coefficient.