Employment and Productivity: Exploring the Trade-off

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Abstract

The prospect of a trade-off between employment growth and productivity growth may create uncertainty among policy makers who strive to create jobs, and at the same time, seek to improve productivity. This article re-visits the issue. It shows that employment growth may be negatively correlated with productivity growth at the industry level. But this is not a trade-off. It is an outcome of market forces in reallocating production resources to rebalance changes in demand and supply conditions of different industries within an economy. At the aggregate level, employment growth may also be negatively correlated with labour productivity growth through its negative influence on capital intensity and labour quality. But, after controlling for those input factors, this article finds that employment growth does not negatively affect multifactor productivity growth.

Is there a trade-off between employment and productivity? A few studies seem to suggest that this is the case. For instance, Freeman (1988) found that the United States paid for high employment growth with slow growth in labour productivity in comparison with slow employment growth and high labour productivity growth in Europe in the 1970s and 1980s. The employment and labour productivity trade-off is also documented by Cavelaars (2004) for OECD countries in the 1960s and 1970s. More recently, De Michelis *et al.* (2013) present cross-country evidence for a strong negative correlation between multifactor productivity (MFP) growth and labour inputs over the medium to long run. The authors conclude "policies that increase production efficiency at the expense of hours of work and/or employment may result in increased unemployment, loss of income for workers, and reduced overall well-being."[2] The latest study has caught the eyes of many policy analysts and policy makers in Canada as it appeared in the *International Productivity*

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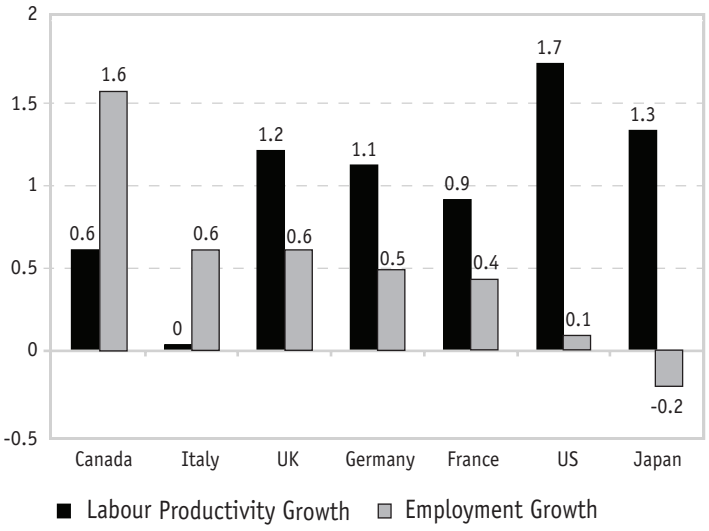
2 In contrast, there have been related empirical studies that have found no such relationship. In studying high labour productivity growth and high unemployment in Europe compared to low labour productivity growth and low unemployment in the United States, Gordon (1995) finds no clear evidence of a trade-off between unemployment and labour productivity growth. He shows that much of the labour productivity growth advantage of the four largest European countries (France, Germany, Italy and the United Kingdom) from 1960 to 1992 over the United States is explained by convergence and by more rapid capital accumulation. In addition, he shows that the only significant effect of higher unemployment is to cause capital accumulation to decelerate, thus reducing the growth rate of labour productivity relative to MFP. Also in a theoretical discussion, Scarth (2005) demonstrates that a policy that addresses inequality via reducing unemployment can also raise productivity.

Chart 1
Total Economy Employment and Labour Productivity (Output per Hour) Growth in G-7 Countries, 2000-2012
(compound annual growth rate)



Sources: OECD, STAT.

Monitor which is widely circulated among Canadian researchers and policy makers.

The view of a trade-off between employment and labour productivity seems to be consistent with the recent observation of a negative correlation between employment growth and labour productivity growth among G-7 countries in the post-2000 period (Chart 1). Over this period, Canada was the best job creator among these countries, with employment growth being the highest, but its labour productivity growth was ranked the second last, only ahead of Italy.

The prospect of a trade-off between the two important economic variables may have undesirable consequences. At the minimum, it may introduce uncertainty and cause hesitation among policy makers. In the words of Scarth (2005), "trade-offs are intimidating to politicians, and as a result, trade-offs make inaction a very tempting strategy."

Is the so-called trade-off between employment and productivity real or artifact? To shed light on this important issue, I re-examine the relationship between employment and productivity. In particular, I focus on the sources of this relationship, which I believe are important for policy makers to better understand and interpret the trade-off between employment and productivity if there is any.

As a starting point, I define a trade-off between two variables as a negative relationship between these variables, that is, an increase in one variable leading to a reduction in the other. In addition, I define a real trade-off between employment and productivity as a negative relationship between employment growth and changes in overall production efficiency (i.e. multifactor productivity growth (MFP)) at the aggregate/national level. I demonstrate theoretically that employment growth may be negatively correlated with productivity growth at the industry level. But this is not a trade-off. It is an outcome of market forces in efficiently reallocating production resources between industries to rebalance the changes in demand and supply conditions of those industries within an economy.

At the aggregate level, for which policy makers care the most, I show that employment growth may indeed be negatively correlated with labour productivity growth. I argue that if this is caused by changes in capital intensity and labour quality, then it is not appropriate to call the negative correlation a trade-off since it is due to the changes in inputs or their combination and does not affect the overall production efficiency (i.e. MFP). Labour productivity is a partial measure of production efficiency. If production becomes more labour intensive, then labour productivity will inevitably be lower. Similarly, when labour quality is reduced because of above-average growth in workers of

below-average qualifications, then one would also expect lower labour productivity growth.

After controlling for those input factors, together with country-specific effects and country differences in industry structure and international trade, I find no cross-country empirical evidence that employment growth is negatively correlated with productivity growth.

The remainder of the article is organized as follows. The first section provides a theoretical discussion of the possible channels for the interaction between employment and productivity. Section 2 presents the regression model, describe the data, and discuss the cross-country empirical evidence. The final section concludes.

The Relationship between Employment and Productivity: A Theoretical Discussion

The relationship between productivity growth and job creation depends on many factors. In this article, I focus on the context and discuss how the productivity concept and industry aggregation play important roles in the relationship.

Labour Productivity and MFP

The productivity concept matters for the relationship between employment and productivity. Both labour productivity and MFP are commonly used to measure production efficiency. The former is often defined as output per hour worked. It is a partial measure, only concerning the production efficiency of labour and ignoring capital input. In contrast, MFP is defined as output per unit of combined input (including labour and capital). It measures how efficiently all inputs are used for producing output.

Under the growth accounting framework (e.g., Jorgenson, 2001), which is commonly used for studying economic growth and productivity, the labour productivity function is

$$\Delta ln LP_t = \Delta ln MFP_t + \overline{v}_{K,t} \Delta ln k_t + \overline{v}_{L,t} \Delta ln q_t \quad (1)$$

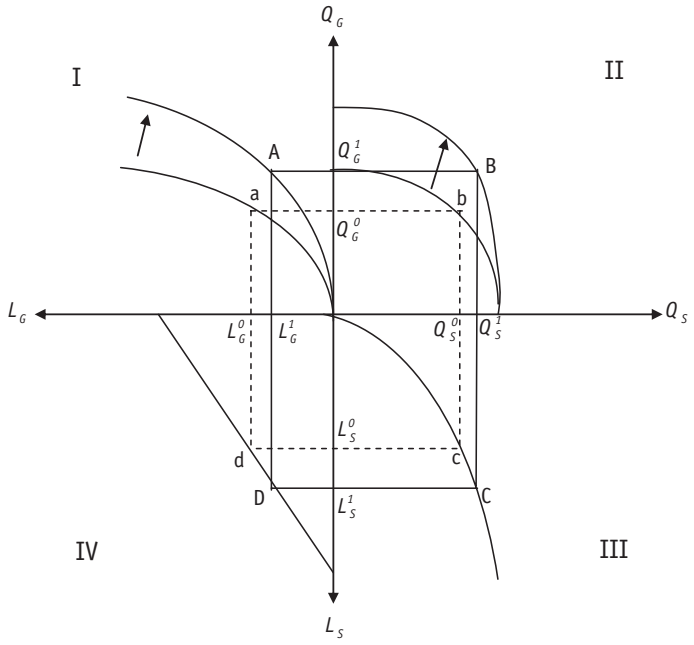
where LP_t is labour productivity, MFP_t is multifactor productivity, k_t is capital intensity (defined as capital input per hour worked), and q_t is labour quality (defined as labour input per hour worked).[3] $\overline{v}_{L,t}$ and $\overline{v}_{K,t}$ are the two-period average labour and capital income shares of value added.

Thus, unlike MFP, labour productivity is influenced by capital intensity and labour quality. It has an important implication for the relationship between productivity and employment. In terms of capital intensity, when labour increases faster than capital due to the substitution of labour for capital (e.g., when labour becomes relatively cheaper than capital) or when the economy shifts from capital-intensive to labour-intensive production, then labour productivity decreases, given constant MFP and labour quality. This will lead to a negative relationship between labour productivity and employment.

Employment growth may also be negatively correlated with labour productivity through its influence on labour quality. Under the growth accounting framework, labour input is commonly adjusted to reflect the composition of the workforce in terms of the gender, age and education levels of workers. It is the sum of hours worked of those different groups, weighted by labour compensation. In other words, hours worked by groups with high labour compensation are weighted more than hours worked by groups with low labour compensation. Compensation here is an indicator for labour quality (or skills). If employment growth is driven by new entrants (e.g., inexperienced young or marginal

3 Capital input is the flow of capital service from quality-adjusted capital stock. Similarly, labour input is hours worked adjusted for work force composition.

Chart 2
Productivity Growth in the "Goods Sector" Creates Jobs in the "Services Sector"



Note: Quadrants I and III are "goods" and "services" production functions, respectively, quadrant II is production possibilities frontier, and quadrant IV is labour demand.

workers) due to improvements in labour market conditions (including labour market programs and institutions) or relative shifts from industries with high paying jobs to industries with low paying jobs, then it will reduce the overall quality of the workforce. This means lower labour productivity growth, leading to a negative relationship between employment growth and labour productivity growth.

In contrast, MFP is measured as a residual – output minus the weighted inputs. It has been controlled for both capital and labour factors, including their quality. Thus, unlike labour productivity, MFP is not directly correlated with employment growth through capital intensity and labour quality.

The term "productivity" in the empirical literature on the relationship between productivity and employment is commonly used to refer to labour productivity (e.g. Freeman 1988; Cavelaars 2004; and Enflo 2010). Thus, a negative relationship between labour productivity and employment is possible, and it is due to a change in the capital-to-labour ratio or due to a change in the composition of the workforce. When all inputs and their quality are counted for, there should be no correlation between employment growth and MFP growth under the framework.

Firm, Industry, and Country

Aggregation also matters. At the firm level, more efficient firms are expected to gain market share and thus hire more employees. This is most likely at the expense of less efficient firms (e.g. Griliches and Regev, 1995). Thus, at the micro level, employment growth is expected to be positively correlated with productivity growth.

At the industry level, however, productivity growth may be negatively correlated with job creation. For example, according to Li *et al.* (2013), the hours worked share of the professional, business, education, health, and social services industries in the Canadian economy (excluding public administration) increased from 18.6 per cent in 1987 to 27.8 per cent in 2010, a 9.2 percentage point increase. In contrast, the share of hours worked in manufacturing decreased 7.4 percentage points from 18.5 per cent to 11.2 per cent. This took place despite stronger labour productivity or MFP growth in manufacturing relative to these services industries. Over the period, labour productivity and MFP annual growth rates in these service industries were on average negative, compared to 2.2 per cent and 1.2 per cent per year respectively for manufacturing.

The change in industry structure and the reallocation of production resources (including labour) from above-average to below-average productivity growth industries

is predicted by the theory of unbalanced growth or the "cost disease model" (Baumol, 1967). This can be illustrated by a model of a simple economy with two sectors characterized by different potential productivity paths (Chart 2). Call the high productivity growth sector "the goods sector" and the low productivity growth sector "the services sector". A positive productivity shock in the goods sector shifts the production possibility frontier outward. This causes income to grow and shifts the consumption mix from point b to point B. The increased demand for goods is more than met by the productivity gain in the goods sector and thus less labour ($L_G^1 - L_G^0$) is required. In contrast, more workers ($L_S^1 - L_S^0$) are hired by the low productivity growth services sector to meet the rise in demand for services.

At the aggregate level, the overall change in employment is ($L_S^1 - L_S^0$)-($L_G^1 - L_G^0$). This can be positive or negative, depending on the production technologies used for producing goods and services and the income and competitiveness effects of the positive productivity shock on demand for both goods and services. Typically, the goods sector is capital intensive and the services sector is labour intensive. This may lead to a positive net job creation. However, the relationship needs to be empirically studied.

Cross-country Empirical Evidence

Building on the theoretical discussion, I now conduct an econometric analysis of the relationship between productivity growth and employment growth using cross-country panel data.

Regression Model

To estimate the relationship between productivity growth and employment growth, I set up the following regression model based on equation (1):[4]

$$\begin{aligned}\Delta ln(LP_{i,t}) &= \alpha_{i,0} + \alpha_1 \Delta ln(k_{i,t}) + \alpha_2 \Delta ln(q_{i,t}) \\ &+ \alpha_3 \Delta ln(E_{i,t}) + \alpha_4 GPC_{i,t-1} + \alpha_5 Agrsh_{i,t-1} \\ &+ \alpha_6 Mansh_{i,t-1} + \alpha_7 Minsh_{i,t-1} \\ &+ \alpha_8 Ex_{i,t-1} + \alpha_9 Im_{i,t-1} + \varepsilon_{i,t}^j \end{aligned} \quad (2)$$

Where $\Delta ln(LP_{i,t})$ is labour productivity growth of country *i* between time *t* and *t-1*, with labour productivity being defined as real GDP per hour worked;

$\Delta ln(k_{i,t})$ is capital intensity growth of country *i* between time *t* and *t-1*, with capital intensity being defined as capital input per hour worked;

$\Delta ln(q_{i,t})$ is labour quality/composition growth of country *i* between time *t* and *t-1*, with labour quality being defined as labour input per hour worked;

$\Delta ln(E_{i,t})$ is employment growth of country *i* between time *t* and *t-1*;

$GPC_{i,t-1}$ is GDP per capita (PPP-based) at the beginning of the period or time *t-1*;

$Agrsh_{i,t-1}$, $Mansh_{i,t-1}$, and $Minsh_{i,t-1}$ are the shares of agriculture, manufacturing and mining sectors in nominal GDP of country *i* at the beginning of the period or time *t-1*;[5]

$Ex_{i,t-1}$ and $Im_{i,t-1}$ are export and import intensities (export/import values as a percentage of nominal GDP) of country *i* at the beginning of the period or time *t-1*; and

$\varepsilon_{i,t}$ is the error term.

The regression model departs from the empirical literature on the trade-off between

4 The regression with productivity as the dependent variable and employment as the independent variable is the most commonly used in the empirical literature on the relationship between employment and productivity. A regression model with employment as the dependent variable and productivity the independent variable is difficult to specify since there are many factors affecting labour demand. Nevertheless, I tried regressions of employment growth against productivity growth while controlling for other factors such as country-specifics, industry structure and trade, and found no evidence of a negative relationship between them.

5 Regression results do not change significantly when hours worked shares are used.

productivity and employment in several aspects. First, I regress labour productivity growth against employment growth while controlling for capital intensity and labour quality, which is basically a regression of MFP growth against employment growth. Most empirical studies on this topic have so far relied on simple regressions of labour productivity growth against employment growth without controlling for capital intensity and labour quality.[6]

Second, I control for industry structure ($Agrsh_{i,t-1}$, $Mansh_{i,t-1}$, and $Minsh_{i,t-1}$). At the aggregate level, the industry structure may play a role in the relationship between productivity and employment. After all, the aggregate productivity level is calculated from industry-specific productivity levels and the industry structure or mix of the economy (Tang, 2014). It is expected that an economy relying on, for example, the goods sector, will have a different relationship between productivity and employment than another economy concentrated in, for example, the services sector due to varying industry productivity performance and different production technologies across industries.

Third, I control for export and import intensities (export/import values as a percentage of nominal GDP). In the global economy, demand conditions for an economy or an industry are influenced by the external forces or international trade, especially for small open economies. Canada's manufacturing and mining sectors are typical examples. In the post-2000 period, the weak U.S. economy, increased competition from low-cost producing countries, and the appreciation of the Canadian dollar significantly reduced the demand for certain manufactured goods in Canada, leading to a shrinking manufacturing sector. At the same time, the rise of emerging economies has increased the demand for commodities, resulting in a booming mining sector in Canada. The change in demand conditions associated with international trade will affect economies of scale and the utilization of production resources (labour and capital), which in turn will affect productivity. For example, Baldwin *et al.* (2013) show that almost all of the productivity growth slowdown in the Canadian manufacturing sector in the post-2000 period was driven by the fall in exports.

Fourth, unlike most previous studies on the trade-off between employment and productivity which do not consider country fixed effects, I introduce a country-specific variable to control for country-specific factors such as demographic and geographic factors, resource endowment, institutions, infrastructure, competition policy, corporate governance, business/marketplace framework, labour market conditions, financial system, monetary policy and fiscal policies.[7] For instance, Bloom and Van Reenen (2007) find significant cross-country differences in corporate management practice, with U.S. firms being better managed than those in many other countries.

Finally, I control for country income levels, approximated by GDP per capita. This control is introduced to capture the convergence or catch-up effect. It has been hypothesized that poor countries tend to grow faster than rich countries. They achieve this through replication of the production methods, technologies and institutions of rich countries. The convergence also reflects slower growth in high income countries due to the diminishing returns of capital in these countries. The sign of the variable is expected to be negative.

6 De Michelis *et al.* (2013) are an exception, using MFP instead of labour productivity. However, their results are based on regressions with 20 or fewer observations, and consequently, should be interpreted with caution.

7 I choose a model with fixed instead of random effects since country-specific heterogeneity in the model might also be correlated with some regressors such as capital intensity and labour quality.

Table 1
List of Countries and the Years with Data

Country	Unbalanced Sample	Balanced Sample 1973-2007	Relative Richness (GDP per capita)	Relative Size (GDP)
Australia	1982-2007		Rich	Large
Austria	1980-2009		Rich	Small
Belgium	1986-2009		Rich	Small
Canada	1970-2008	Yes	Rich	Large
Czech Republic	1995-2007		Poor	Small
Denmark	1980-2007		Rich	Small
Finland	1970-2007	Yes	Rich	Small
France	1980-2009		Rich	Large
Germany	1991-2009		Rich	Large
Greece	1992-2007		Poor	Small
Hungary	1995-2007		Poor	Small
Ireland	1988-2007		Rich	Small
Italy	1972-2009	Yes	Rich	Large
Japan	1973-2009	Yes	Rich	Large
Korea	1989-2007		Poor	Large
Netherlands	1988-2009		Rich	Large
Poland	1995-2007		Poor	Large
Portugal	1989-2007		Poor	Small
Slovak Republic	1995-2007		Poor	Small
Slovenia	1995-2007		Poor	Small
Spain	1980-2009		Poor	Large
Sweden	1993-2007		Rich	Small
United Kingdom	1972-2009	Yes	Rich	Large
United States	1970-2009	Yes	Rich	Large

Note: The grouping of the "rich" and the "poor" is based on average GDP per capita (constant PPP-adjusted price) over the 1995-2007 period. The grouping of the "small" and the "large" is based on the average size of GDP (PPP-based) over the 1995-2007 period.

Data

The data for our empirical analyses are mainly from EUKLEMS and World KLEMS databases.[8] These databases are developed, as a joint effort by OECD member countries, to ensure consistent and reasonable comparable production data for cross-country studies of productivity and economic growth. I extracted data on both outputs and inputs, including value added (both nominal and real), labour (quality-adjusted labour input, employment, hours worked, and labour compensation), and capital (capital input and capital compensation).[9] These data are supplemented by OECD data on GDP (PPP-based), export, import, total population, and working population. As a result, I obtained an unbalanced panel data for 24 countries over the 1970-2009 period. The list of countries and the number of observations for each of them are reported in Table 1.[10]

8 See O'Mahony and Timmer (2009) on the EUKLEMS program and Jorgenson (2012) on the World KLEMS initiative.

9 For some countries, data on capital input and labour input are not available from either EUKLEMS or World KLEMS. The missing data (i.e, capital input for Greece, Korea, Poland, Portugal and the Slovak Republic and labour input for Poland and Portugal) are replaced by data from the total economy database of the U.S. Conference Board. For Slovenia, output, capital and labour data are extended one more year to 2007 using data based on the total economy database.

10 Many countries are constrained by a lack of capital input data. When capital input is not required, the sample size increases substantially.

Chart 3

Simple Correlation between Labour Productivity Growth and Employment Growth for 24 OECD Countries, 1995-2007

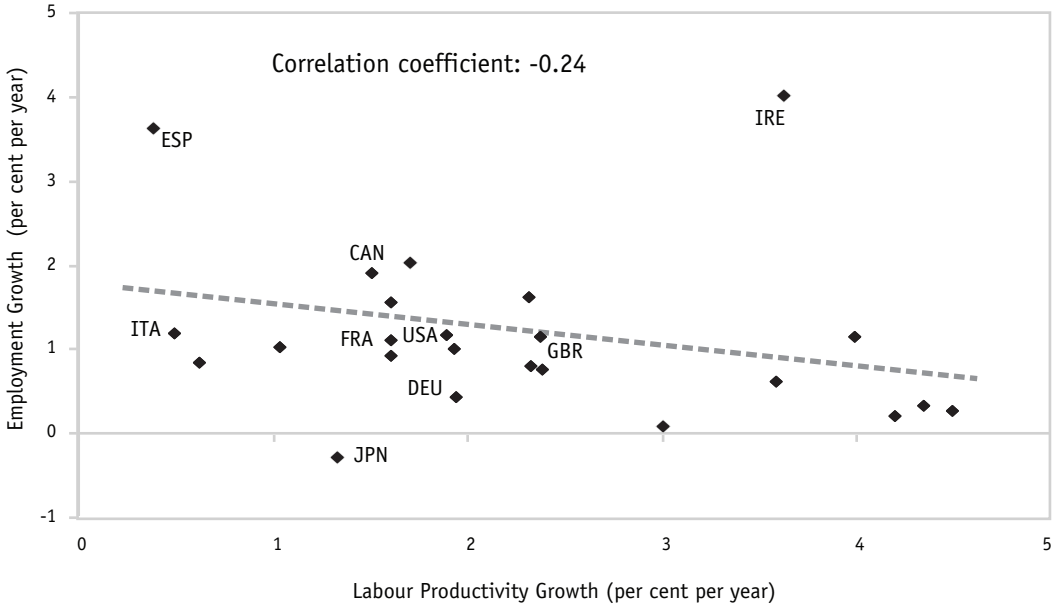
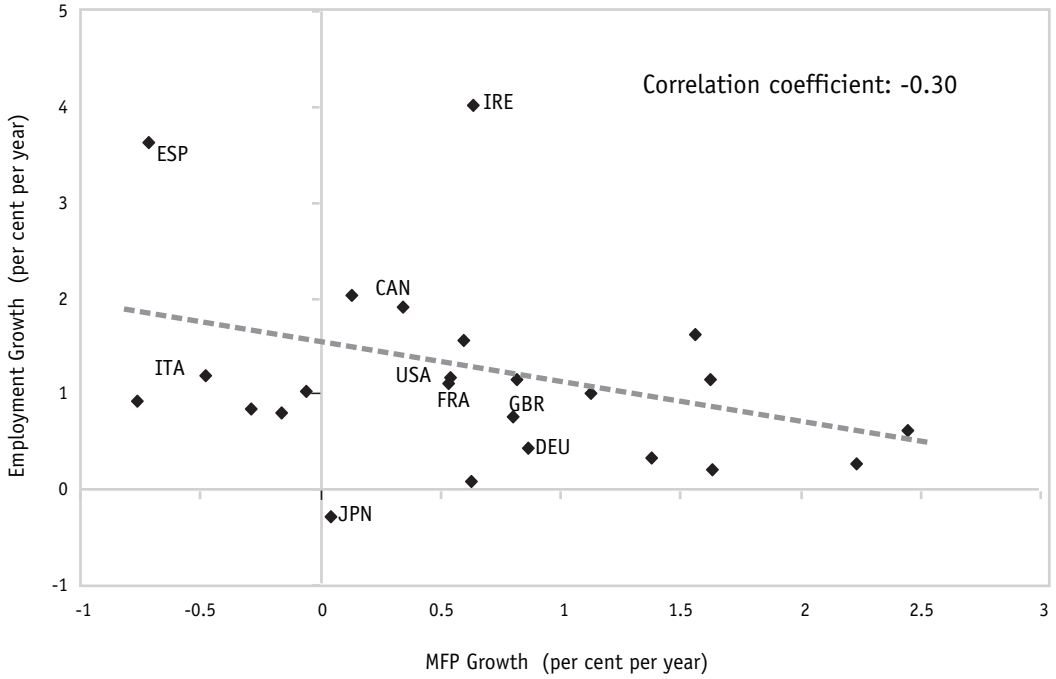


Chart 4

Simple Correlation between MFP Growth and Employment Growth for 24 OECD Countries, 1995-2007



Simple Correlation between Productivity Growth and Employment Growth

All 24 countries had data for the 1995-2007 period. Over this period, both labour productivity growth and MFP growth were negatively correlated with employment growth, as illustrated in Charts 3 and 4, respectively.[11] It is interesting to note that over the period, Canada outperformed many other countries including all other G7 nations in employment growth, but underperformed most of the countries in productivity growth. This is similar to the observation for the post-2000 period (Chart 1).

The correlation coefficient between labour productivity growth and employment growth was -0.24. Ireland is an outlier. When it was excluded, the coefficient was -0.50. For MFP growth, the correlation coefficient was -0.30 (or -0.38 when Ireland was excluded). The finding of a negative relationship between both labour productivity and multifactor productivity growth and employment growth is similar to that found by De Michelis *et al.* (2013) based on 20 OECD countries for the 1970-2007 period.

However, the simple correlation that quantifies the association between labour productivity growth and employment growth should not be interpreted as a trade-off without further investigation. The association does not control for other factors that may influence the interdependence of the two variables. For instance, it neither controls for capital intensity and labour quality (for labour productivity) nor for country-specific effects, industry structure and international trade.

To provide a vigorous analysis of the dependence of one variable on another variable with control for other factors, an econometric analysis is required.

Discussion of Regression Results

I first regress labour productivity growth against employment growth, using the unbalanced panel data for 24 OECD countries for the 1970-2009 period. The panel least square estimation shows that employment growth was negatively correlated with labour productivity growth, and the estimated coefficient was statistically significant at the 5 per cent level (Table 2, Column 1).

The regression, however, has very limited explaining power since the adjusted R-square was almost zero. For the next regression, column (2), I control for country-specific effects. The estimation shows that employment growth was negative and significant. The adjusted R-square increased significantly to 0.15. This suggests that country-specific conditions were important for productivity growth. The results continue to hold after correcting for auto-correlation (i.e. a productivity shock in the previous period is affecting productivity growth in the current period), as shown in Column (3). The result is in line with the prediction that employment growth is negatively correlated with labour productivity through its impact on capital intensity and labour quality, as discussed earlier.

In regression (4), I add controls for growth in capital intensity and labour quality. The two added variables were positive and significant, especially growth in capital intensity. Most importantly, however, employment growth was now positive and highly significant, indicating employment growth was moving in the same direction as productivity growth.

I then control for GDP per capita (PPP-based), industry structure, and international trade in regressions (5) and (6). These two new regressions continue to show that employment growth was positively correlated

11 MFP growth is calculated as labour productivity growth minus the contributions from changes in capital intensity and labour quality, as shown in equation (1).

Table 2

Regressions of Labour Productivity Growth against Employment Growth

(annual rate, unbalanced panel data with 24 OECD countries for 1970-2009)

	Panel Least Squares						GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Constant	0.026 (0.002)***	0.026 (0.002)***	0.025 (0.002)***	0.001 (0.003)	0.527 (0.135)***	0.538 (0.147)***	0.497 (0.142)***
Capital intensity growth				0.468 (0.047)***	0.469 (0.047)***	0.498 (0.066)***	0.450 (0.052)***
Labour quality growth				0.167 (0.093)*	0.150 (0.090)*	0.147 (0.082)*	0.145 (0.088)
Employment growth	-0.166 (0.080)**	-0.220 (0.092)**	-0.218 (0.112)*	0.243 (0.066)***	0.258 (0.066)***	0.244 (0.066)***	0.063 (0.133)
Lagged GDP per capita					-0.064 (0.017)***	-0.070 (0.018)***	-0.064 (0.017)***
Lagged agriculture share					-0.022 (0.008)***	-0.020 (0.008)**	-0.018 (0.008)**
Lagged manufacturing Share					-0.017 (0.015)	-0.032 (0.015)**	-0.025 (0.015)*
Lagged mining share					-0.003 (0.004)	-0.003 (0.003)	-0.003 (0.003)
Lagged export intensity						0.044 (0.010)***	0.044 (0.010)***
Lagged import intensity						-0.050 (0.012)***	-0.051 (0.012)***
AR(1)			0.262 (0.075)***	0.297 (0.057)***	0.342 (0.064)***	0.359 (0.063)***	0.346 (0.062)***
Country-fixed effect	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	792	792	768	548	540	536	536
Adjusted R-squared	0.01	0.15	0.20	0.45	0.47	0.50	0.49

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting significance at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regression (7) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

with productivity growth. Note, however, that GDP per capita was negative and highly significant. This suggests that there was a convergence or catch-up effect with relatively poor countries experiencing faster productivity growth than relatively rich countries. In addition, the estimation shows that countries that relied on agriculture or imports had lower productivity growth, while those with higher export intensity had higher productivity growth.[12]

No matter the direction of causality, a positive relationship between growth in employment and labour productivity indicates that there is no trade-off between the two variables. However, in the final regression, Column (7), I estimate the regression model using the general method of moments (GMM) to ensure unbiased estimation. The estimation deals with the endogeneity issue not only due to the causality from productivity growth to employment growth but also due to missing

12 The estimation also shows that countries with a higher manufacturing share tended to have lower productivity growth than other countries, but the result was not robust for some sub-samples, which will be discussed later on.

Table 3

Regressions of Labour Productivity Growth against Employment Growth

(annual rate, balanced panel data with 6 OECD countries for 1973-2007)

	Panel Least Squares						GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Constant	0.021 (0.002)***	0.020 (0.002)***	0.021 (0.002)***	0.003 (0.003)	0.740 (0.229)***	0.665 (0.221)***	0.638 (0.218)***
Capital intensity growth				0.371 (0.047)***	0.405 (0.030)***	0.410 (0.020)***	0.387 (0.032)***
Labour quality growth				0.631 (0.122)***	0.507 (0.110)***	0.587 (0.102)***	0.599 (0.104)***
Employment growth	-0.171 (0.071)**	-0.090 (0.074)	-0.096 (0.090)	0.168 (0.126)	0.235 (0.100)**	0.223 (0.099)**	0.100 (0.157)
Lagged GDP per capita					-0.093 (0.028)***	-0.086 (0.026)***	-0.083 (0.025)***
Lagged agriculture share					-0.031 (0.011)***	-0.021 (0.010)**	-0.021 (0.010)**
Lagged manufacturing Share					-0.041 (0.019)**	-0.053 (0.018)***	-0.047 (0.019)**
Lagged mining share					-0.006 (0.004)	-0.007 (0.004)*	-0.007 (0.004)*
Lagged export intensity						0.044 (0.011)***	0.043 (0.011)***
Lagged import intensity						-0.048 (0.011)***	-0.048 (0.011)***
AR(1)			0.271 (0.101)***	0.228 (0.096)**	0.314 (0.097)***	0.306 (0.081)***	0.304 (0.089)***
Country-fixed effect	No	Yes	Yes	Yes	Yes	Yes	Yes
Observations	204	204	198	198	198	198	198
Adjusted R-squared	0.02	0.06	0.13	0.45	0.49	0.55	0.54

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting significance at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regression (7) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

variables that are correlated with employment growth. I use working-age population growth and lagged tax rate (total tax revenue as percentage of GDP) as the instrument variables.[13] The GMM estimation continues to show that employment growth was positively linked to labour productivity growth, although the relationship became statistically insignificant.

Robustness of the Regression Results

In the remainder of the article, I conduct additional regressions to check the robustness of the above regression results associated with the relationship between employment growth and productivity growth. The effort does not intend to be exhaustive. Instead, it provides some evi-

13 Working population growth and lagged tax rate are found to be correlated with employment growth. The estimated coefficients of employment growth against working population growth and lagged tax rate are 0.904 and -0.012, being significant at 1 percent and 10 percent levels respectively. In contrast, the estimated coefficients of productivity growth against those two instrumental variables are insignificant (0.005 and -0.002, respectively). In addition, a J test for overidentifying restrictions indicates that the instrument variables are uncorrelated with the error process.

Table 4

Regressions of Labour Productivity Growth against Employment Growth

(Annual Rate, Unbalanced Panel Data with Relatively Rich vs. Poor Countries, 1970-2009)

	Relatively Rich Countries			Relatively Poor Countries		
	Panel Least Squares		GMM	Panel Least Squares		GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	-0.001	0.612	0.620	-0.003	0.714	0.607
	(0.003)	(0.159)***	(0.175)***	(0.005)	(0.319)***	(0.307)***
Capital intensity growth	0.427	0.446	0.398	0.627	0.813	0.746
	(0.035)***	(0.048)***	(0.033)***	(0.093)***	(0.068)***	(0.091)***
Labour quality growth	0.650	0.564	0.559	-0.019	-0.017	-0.015
	(0.156)***	(0.122)***	(0.127)***	(0.028)	(0.041)	(0.042)
Employment growth	0.210	0.189	-0.055	0.366	0.436	0.300
	(0.085)**	(0.077)**	(0.151)	(0.081)***	(0.060)***	(0.156)*
Lagged GDP per capita		-0.081	-0.082		-0.078	-0.063
		(0.019)***	(0.020)***		(0.040)*	(0.039)
Lagged agriculture share		-0.023	-0.024		-0.051	-0.044
		(0.009)***	(0.010)**		(0.018)***	(0.018)**
Lagged manufacturing Share		-0.040	-0.032		0.016	0.021
		(0.016)**	(0.017)*		(0.031)	(0.030)
Lagged mining share		-0.004	-0.004		0.003	0.005
		(0.003)	(0.002)*		(0.021)	(0.021)
Lagged export intensity		0.037	0.037		0.101	0.099
		(0.009)***	(0.009)***		(0.031)***	(0.032)***
Lagged import intensity		-0.047	-0.047		-0.095	-0.093
		(0.010)***	(0.011)***		(0.033)***	(0.034)***
AR(1)	0.255	0.304	0.316	0.347	0.507	0.471
	(0.065)***	(0.068)***	(0.068)***	(0.081)**	(0.107)***	(0.110)***
Country-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	417	409	309	131	127	127
Adjusted R-squared	0.42	0.49	0.47	0.51	0.58	0.57

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting significance at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regressions (3) and (6) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

dence that the empirical results are fairly robust for different groups of the sample.

Balanced Panel

The econometric analysis has so far been based on an unbalanced panel with 24 countries in the 1970-2010 period. Most missing observations are from low income countries in the early years of this period as shown in Table 1. The specific pattern indicates that the observations were not missing at random, which may lead to biased and inconsistent estimation results.

To see if the unbalanced panel being not random is an issue for our results, I re-estimate the regressions in Table 2, using a balanced panel with six countries for 1973-2007, extracted from the unbalanced panel. The six countries are Canada, Finland, Italy, Japan, the United Kingdom, and the United States.

The new estimation results were in general similar to those based on the unbalanced panel (Table 3). They continue to show that employment growth was positively correlated with productivity growth after controlling for capital intensity, labour quality, industry structure, and international trade, although it was not significant when the GMM was used (Table 3). For regressions with these six countries, I observe

that labour quality became highly significant and that the sum of the estimated coefficients on capital intensity and labour quality was very close to unity. This might suggest higher quality production data for those countries.

Relatively Rich Countries vs Relatively Poor Countries

The estimation has so far been based on data from a mix of 24 high income and low income OECD countries. Rich countries tend to be more developed than poor countries in many aspects, including labour market policies, programs and institutions. Can the estimation results be generalized to either rich or poor countries? To address this question, I divide the 24 countries into the "rich" and the "poor," based on average GDP per capita (constant PPP-adjusted price) over the 1995-2007 period. The 15 countries with the highest average levels of GDP per capita are labeled the "rich" and the remaining 9 countries are the "poor" (Table 1). I have more rich than poor countries since I am more comfortable to include France, Italy and Finland in the rich camp. They will otherwise be in the poor camp when equal number countries in the two groups are forced.

The division of the sample did not change our main result, that is, employment growth was not negatively and significantly correlated with productivity growth for both groups of countries (Table 4). On the contrary, most of the regressions show that the relationship was positive and significant, especially for the relatively poor countries.

For the relatively rich countries, labour productivity growth was significantly correlated with both capital intensity growth and labour quality growth; however, for the relatively poor countries, it was only significantly correlated with capital intensity growth. The result on labour quality for the two groups of countries might also indicate that the labour quality estimate was too noisy for the relatively poor countries. Note also that the catch-up effect was very strong among the relatively rich countries, but was only marginal for the relatively poor countries.

1970-1994 vs 1995-2010

The relationship between employment growth and productivity growth may change from one period to another due to changes in labour market conditions and globalization. To see if this is the case in the first half of the sample period compared to the second half of the sample period, I divide the whole sample period into two sub-periods: 1970-1994 and 1995-2010. The division allows enough observations for each sub-period. I re-run the regressions independently. The estimation shows that there was no significant change in the relationship between employment growth and labour productivity growth between the 1970-1994 and 1995-2010 sub-periods. Most importantly, the estimation shows that employment growth was positively correlated with labour productivity growth although the relationship was not significant when the GMM is used.

The estimation also shows that labour quality was positive, but only highly significant for the 1970-1994 sub-period (Table 5). The result is consistent with the early estimation showing that labour quality was only significant for the relatively rich countries since most of the relatively poor countries do not have observations for the 1970-1994 sub-period.

Small vs Large

Does country size matter? When a country is small, its economy may be relatively concentrated in certain sectors, for example, high-tech (Nokia) in Finland and mining and oil and gas in Canada. As a result, both productivity and employment in small countries might be more volatile and sensitive to specific shocks. To check the sensitivity of the relationship between employment growth and productivity growth, I

Table 5

Regressions of Labour Productivity Growth against Employment Growth

(annual rate, unbalanced panel data 1970-1994 vs 1995-2009)

	1970-1994			1995-2010		
	Panel Least Squares		GMM	Panel Least Squares		GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	-0.001	0.812	0.739	0.001	0.359	0.363
	(0.005)	(0.165)***	(0.145)***	(0.003)	(0.293)	(0.298)
Capital intensity growth	0.487	0.677	0.537	0.432	0.455	0.460
	(0.124)***	(0.084)***	(0.089)***	(0.050)***	(0.066)***	(0.080)***
Labour quality growth	0.459	0.320	0.403	0.100	0.091	0.093
	(0.109)***	(0.121)***	(0.122)***	(0.092)	(0.078)	(0.093)
Employment growth	0.189	0.391	0.135	0.284	0.266	0.292
	(0.095)**	(0.089)***	(0.136)	(0.084)***	(0.074)***	(0.228)
Lagged GDP per capita		-0.112	-0.099		-0.051	-0.052
		(0.020)***	(0.016)***		(0.029)*	(0.030)*
Lagged agriculture share		-0.031	-0.026		-0.019	-0.019
		(0.012)***	(0.010)**		(0.007)***	(0.007)***
Lagged manufacturing Share		-0.107	-0.086		-0.009	-0.011
		(0.030)***	(0.025)***		(0.016)	(0.022)
Lagged mining share		0.000	0.000		-0.011	-0.012
		(0.004)	(0.004)		(0.005)**	(0.005)**
Lagged export intensity		0.047	0.044		0.056	0.056
		(0.011)***	(0.011)***		(0.018)***	(0.017)***
Lagged import intensity		-0.053	-0.051		-0.060	-0.059
		(0.012)***	(0.013)***		(0.022)***	(0.020)***
AR(1)	0.213	0.182	0.154	0.278	0.304	0.302
	(0.072)***	(0.076)***	(0.074)**	(0.097)**	(0.120)***	(0.101)***
Country-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	241	235	235	307	301	301
Adjusted R-squared	0.37	0.56	0.53	0.52	0.55	0.55

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting significance at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regressions (3) and (6) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

divided equally the 24 countries in our sample into two groups based on average size of GDP (PPP-based) over the 1995-2007 period. The division is listed in Table 1.

Again, there was no evidence of a significant negative correlation between employment growth and labour productivity growth for either large or small countries (Table 6).

MFP Growth as the Dependant Variable

To establish a linkage between employment growth and productivity growth, I can directly regress MFP growth against employment growth. As shown in Equation (1), MFP growth is calculated as labour productivity growth minus contributions from growth in capital intensity and labour quality. The advantage of such a new regression is that it can eliminate any multi-collinearity problem of employment with capital intensity and labour quality, although this is not expected to be a significant issue since the correlation of employment growth with growth in capital intensity was -0.32 and -0.06 for growth in labour quality. The disadvantage is that I lose

Table 6

Regressions of Labour Productivity Growth against Employment Growth

(annual rate, unbalanced panel data, small vs large countries, 1970-2009)

	Large			Small		
	Panel Least Squares		GMM	Panel Least Squares		GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	-0.002	0.581	0.479	0.005	0.364	0.365
	(0.004)	(0.166)***	(0.154)***	(0.004)	(0.244)	(0.247)
Capital intensity growth	0.483	0.497	0.427	0.447	0.498	0.522
	(0.063)***	(0.083)***	(0.057)***	(0.095)***	(0.082)***	(0.084)***
Labour quality growth	0.236	0.206	0.187	0.068	0.032	0.027
	(0.155)	(0.140)	(0.152)	(0.068)	(0.077)	(0.077)
Employment growth	0.265	0.206	-0.053	0.191	0.210	0.268
	(0.092)***	(0.140)	(0.140)	(0.122)	(0.145)	(0.155)*
Lagged GDP per capita		-0.077	-0.064		-0.047	-0.048
		(0.020)***	(0.019)***		(0.026)*	(0.027)*
Lagged agriculture share		-0.030	-0.022		-0.003	-0.003
		(0.013)**	(0.013)*		(0.009)	(0.009)
Lagged manufacturing Share		-0.026	-0.018		-0.033	-0.036
		(0.017)	(0.017)		(0.028)	(0.027)
Lagged mining share		0.000	-0.000		-0.008	-0.008
		(0.004)	(0.004)		(0.005)*	(0.005)*
Lagged export intensity		0.031	0.031		0.068	0.069
		(0.008)***	(0.008)***		(0.022)***	(0.022)***
Lagged import intensity		-0.040	-0.041		-0.070	-0.071
		(0.010)***	(0.010)***		(0.022)***	(0.022)***
AR(1)	0.243	0.303	0.266	0.357	0.346	0.346
	(0.086)	(0.072)***	(0.075)***	(0.067)**	(0.082)***	(0.084)***
Country-fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	330	329	329	218	207	207
Adjusted R-squared	0.48	0.54	0.50	0.37	0.39	0.39

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting significance at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regressions (3) and (6) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

the flexibility in the elasticities of output with respect to capital and labour. In addition, I have to implicitly assume constant returns to scale production and elasticities of output with respect to capital and labour being their income shares respectively.

The regression results are reported in Table 7. They are in general similar to the findings based on labour productivity growth as the dependent variable. They show that employment growth was not negatively and significantly correlated with multifactor productivity growth.

Regressions with Growth over a Five-Year Period

The relationship between employment growth and productivity growth may also be subject to cyclical factors and measurement issues, which may dominate any trend change over a short period, as pointed out by Blanchard (2004). To minimize the potential problem, I re-estimated the regression model of labour productivity growth against employment growth, based on a five-year average growth rate instead of an annual growth rate. The regression results are reported in Table 8.[14]

14 I also performed the same exercise based on the balanced panel data for the six countries. Similar results were obtained.

Table 7

Regressions of MFP Growth against Employment Growth

(annual rate, unbalanced panel data with 24 OECD countries for 1970-2009)

	Panel Least Squares					GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.004 (0.001)***	0.004 (0.001)***	0.003 (0.002)*	0.486 (0.012)***	0.503 (0.124)***	0.475 (0.125)***
Employment growth	0.106 (0.060)*	0.143 (0.062)**	0.174 (0.061)***	0.189 (0.060)***	0.170 (0.057)***	-0.000 (0.107)
Lagged GDP per capita				-0.056 (0.015)***	-0.061 (0.015)***	-0.057 (0.015)***
Lagged agriculture share				-0.020 (0.007)***	-0.017 (0.007)**	-0.016 (0.007)**
Lagged manufacturing Share				-0.010 (0.014)	-0.023 (0.014)	-0.018 (0.014)
Lagged mining share				0.000 (0.003)	0.000 (0.003)	-0.000 (0.003)
Lagged export intensity					0.034 (0.009)***	0.037 (0.009)***
Lagged import intensity					-0.037 (0.010)***	-0.041 (0.010)***
AR(1)			0.215 (0.072)***	0.204 (0.076)***	0.213 (0.077)***	0.219 (0.083)***
Country-fixed effect	No	Yes	Yes	Yes	Yes	Yes
Observations	570	570	546	539	535	535
Adjusted R-squared	0.01	0.11	0.13	0.16	0.19	0.17

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting to be significant at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regressions (3) and (6) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

Interestingly, for the first time, employment growth was negative and significant, after controlling for growth in capital intensity and labour quality, as shown in regression (5). However, after dealing with the potential endogeneity issue associated with employment growth, the GMM estimation, regression (6), shows that employment growth was positive, although it was insignificant. Thus, the new regression results are in general consistent with previous findings.

Notably, the linkage of labour productivity with capital intensity or labour quality now breaks down. This limited evidence may suggest that the relationship between output and inputs are more on a contemporary basis. In other words, regressions based on annual growth rates may fit the data better than those based on average five-year growth rates, a conjecture requiring further research.

Conclusion

A number of empirical studies on economic performance suggest that there is a trade-off between employment and productivity. If true, the trade-off stands to be a great challenge for policy makers who strive to boost economic growth through job creation and productivity improvement.

I re-visited the prospect of a trade-off between employment and productivity, and in particular examined the sources of this relationship. I theoretically demonstrated that employment growth and productivity growth may be

Table 8

Regressions of Labour Productivity Growth against Employment Growth

(5-year rate, unbalanced panel data with 24 OECD countries for 1970-2009)

	Panel Least Squares					GMM
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.102 (0.008)***	0.105 (0.010)***	0.039 (0.009)***	0.707 (0.321)**	0.563 (0.369)	0.450 (0.484)
Capital intensity growth			0.257 (0.054)***	0.093 (0.094)	0.124 (0.110)	0.202 (0.197)
Labour quality growth			0.390 (0.310)	0.240 (0.266)	0.230 (0.330)	0.305 (0.384)
Employment growth	-0.086 (0.059)	-0.162 (0.053)***	0.058 (0.068)	-0.105 (0.076)	-0.142 (0.057)**	0.054 (0.341)
Lagged GDP per capita				-0.070 (0.035)*	-0.064 (0.036)*	-0.046 (0.051)
Lagged agriculture share				0.223 (0.361)	0.452 (0.362)	0.213 (0.594)
Lagged manufacturing Share				-0.032 (0.041)	-0.034 (0.040)*	-0.022 (0.046)
Lagged mining share				-0.002 (0.007)	-0.004 (0.007)*	0.002 (0.011)
Lagged export intensity					0.028 (0.046)	0.021 (0.047)
Lagged import intensity					-0.038 (0.047)	-0.025 (0.046)
Country-fixed effect	No	Yes	Yes	Yes	Yes	Yes
Observations	188	188	123	121	120	120
Adjusted R-squared	0.00	0.26	0.57	0.62	0.61	0.59

Note: The White cross-section standard error is reported in the parenthesis, with "*", "**", and "***" denoting to be significant at 10%, 5% and 1%, respectively. The instrument variables for employment growth in regression (6) are working population growth and lagged tax rate (tax revenue as percentage of GDP).

negatively correlated at the industry level, along the lines of Baumol's "cost disease model," which predicts that lower productivity growth industries tend to absorb employment released from high productivity growth industries. This, however, is not a real trade-off between employment and productivity. It is an outcome of market forces in reallocating production resources between industries to rebalance the changes in demand and supply conditions of the industries within an economy.

Employment growth may also be negatively correlated with labour productivity growth, even at the aggregate level. But the relationship should not be viewed as a trade-off between production efficiency and employment. Labour productivity is a partial measure of production efficiency, and it is expected to be influenced when employment growth changes capital intensity and labour quality.[15] But when those input factors are controlled for, employment growth is not expected to be negatively correlated with the broader measure of production efficiency, MFP growth.

Using KLEMS data for 24 OECD countries, I empirically showed that at the aggregate level there is no evidence of a negative relationship between employment growth and labour productivity growth, after controlling for capital intensity, labour quality, industry structure, and

15 This is consistent with the finding by Boulhol and Turner (2009).

international trade. This finding was robust for rich or poor countries, small or large, and over the pre- or post-1995 period.

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