Hours Worked over the Business Cycle in OECD Countries, 1960 - 2010*

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Abstract

This paper constructs a new dataset for total hours worked at the quarterly frequency for 14 OECD countries over the last fifty years. We find that key cyclical features of labor markets across countries differ markedly from the empirical regularities reported in the literature based on just U.S. data or on international employment data. We document that total hours in many OECD countries are about as volatile as output, that the volatility of total hours relative to output volatility has increased over time in almost all countries, and a large fraction of labor market adjustment takes place along the intesive margin outside the United States. We also find a number of puzzles regarding labor wedges in Europe. In recessions, the cyclical labor wedges for European countries constructed using employment appear to be much too large, while the labor wedges constructed using hours appear to be much too small. The Great Recession in many OECD countries represents a major puzzle in that both hours-based and employment-based labor wedges are roughly zero, while those in the U.S. Great Recession - and those in previous European recessions - are roughly an order

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of magnitude larger. This indicates that understanding many OECD recessions requires analyzing why and how their labor markets changed so much in the last few years, and why these labor markets during recessions appear to be inconsistent with theories of firing costs.

1 Introduction

Documenting and understanding cyclical changes in hours worked has been a primary focus of business cycle research since at least Kydland and Prescott (1982) and Hansen (1985), and the very different labor market outcomes observed during the 2008-09 recession across countries have generated renewed interest in the evolution of labor input during fluctuations. However, this research has usually focused on the U.S. due to the very limited availability of systematic measures of aggreate hours worked in other countries, including other high income countries. Consequently, what is known about cyclical changes in labor input and productivity in other countries is largely based on measures of employment.

This means that studies of cyclical fluctuations in other countries largely abstract from documenting and analyzing changes in the intensive labor margin, and that these studies of international fluctuations are not comparable to analyses of U.S. fluctuations. This omission of the intensive margin is an important limitation for a number of reasons. One reason is that it limits the extent that conclusions about cyclical changes in labor can be drawn across these countries. Another is because it is generally accepted that hiring and firing costs are much higher in Europe than in the U.S., which suggests that the relative size of fluctuations in the intensive versus extensive margin may be very different. Since at least the influential work of Hopenhayn and Rogerson (1993), many economists argue that European labor markets provide an excellent setting for quantifying the impact of labor market distortions and policies, but this laboratory is significantly limited for addressing cyclical fluctuations due to data limitations on hours worked.

This paper addresses these shortcomings by first constructing a new dataset for total hours worked at the quarterly frequency which covers 14 OECD countries and spans the last fifty years. The dataset draws on a variety of international sources, including data from national statistical offices, establishment surveys, and household surveys. There are two contributions. One is to provide the most comprehensive, international database of hours

worked that can be used by other researchers. The second is to document and interpret cyclical fluctuations in hours by comparing fluctuations between the U.S. and other countries, with a focus on the relative importance of hours per worker versus employment as a determinant of changes in hours worked, the cyclical properties of hours versus employment, and the cyclical patterns of the labor and productivity wedges and their implications for understanding fluctuations.

This paper addresses these issues by presenting quarterly measures of total hours worked for a number of OECD countries from 1960 to 2010. We construct these measures consistently across countries according to national income and product account constructs. We use these measures to compare business cycle properties of total hours worked across OECD countries, including the U.S. We focus our analysis on three questions: (1) How sensitive are accepted business cycle features in OECD countries based on employment to using hours? (2) What fraction of fluctuations in labor are due to hours versus employment, and how have these features changed over time? (3) What fraction of fluctuations in output and labor across countries is accounted for by labor versus productivity wedges? (4) How does the Great Recession in other OECD countries, using hours versus employment, compare to that in the U.S.?

This last question is important, as Ohanian (2010) documents large differences in this recession between the U.S. and other advanced economies. He finds that in the U.S., productivity is close to trend, and that the U.S. Great recession is almost entirely due to a very large decline in hours worked. Moreover, the source of lower U.S. hours is related to an historically large distortion in the relationship between the aggregate marginal rate of substitution between consumption and leisure and aggregate labor productivity. In the other G7 countries, in which labor input is measured using employment, he finds that the Great Recession is largely the consequence of large productivity declines, with only very small employment declines and no distortion in the marginal rate of substitution -marginal product of labor relationship. This paper uses hours worked to re-assess Ohanian's analysis

of the Great Recession, which is important to pursue, as the small changes in Western European employment may reflect large firing costs, and that labor may have declined considerably through declines in hours per worker.

Our main findings contrast with commonly held views in some cases, and raise significant puzzles in other cases. Specifically, employment is a poor proxy for labor input in many OECD countries, as changes in hours per worker are about as large as changes in employment. We also find that employment-based labor wedges are much too large in Europe, given high European firing costs, while hours-based labor wedges are much too small. Finally, we find that the Great Recession is a substantial puzzle in Europe, as both employment-based and hours-based labor wedges are nearly zero in many European countries. This stands in sharp contrast to labor wedges in the U.S. during the Great Recession, or wedges in other European recessions, both of which are an order of magnitude larger.

The paper is organized as follows. Section 2 describes the data sources and the approach we use to construct the hours measures. Section 3 compares standard business cycle features, including the cyclical volatility of hours, employment, and productivity, and their correlation with output across countries. Section 4 uses the business cycle accounting approach developed by Cole and Ohanian (2002), and Chari, Kehoe, and McGrattan (2007), to construct labor and productivity wedges using both emloyment and hours for recessions since 1960, with a specific focus on assessing the relative importance of these wedges during the Great Recession. Section 5 concludes.

2 Data

In this section, we briefly discuss our methodology to construct time-series of hours per worker across countries. The Appendix presents details about the country-specific estimation procedures and sources.

Hours per worker

Official series for quarterly hours worked in advanced economies are typically short and their comparability across coutries is often considered problematic. In our sample, hours worked series collected from the national agencies start around 1980. Moreover, the underlying surveys used to construct these series, whether sampling establishments or the labor force, are not uniform across countries and, in some cases, for the same country at two different dates.

Establishments surveys have been conducted in many countries at a quarterly or even monthly frequency since the 1960s, but they often collect hours paid for and not hours actually worked for. Thus, they do not account for differences across countries in important elements of labor contracts such as paid vacation or sick days. In addition, these surveys do not sample all sectors of the economy. For instance, the government sector is often neglected by these surveys.

Labor force surveys tend to be more comprehensive since they sample directly individuals in the labor force, but they suffer from several shortcomings as well. First, it is well-known that these surveys present an upward bias for the estimated working time due to self-reporting. In addition, there are methodological differences across countries in the construction of these surveys which might also affect the concept of working time measured, thus undermining their comparability[1]. Last, but not least, in many countries labor force surveys have been conducted primarily at a annual frequency until very recently.

Our methodology to construct quarterly series of hours per worker consists of three elements, namely a dataset of annual hours worked that deals with the aforementioned issues, a dataset of quarterly indicators for hours worked (which we construct), and a procedure to adjust the quarterly indicators using the information contained in the annual dataset.

[1]For instance, some countries do not include in their questionnaires a distinction between contractual hours and hours not worked because of illness or holidays.

Annual estimates of hours worked are currently available through the Conference Board Total Economy Database (TED). This database, originally developed by the Groningen Growth and Development Centre (GGDC) and subsequently updated in partnership with the Conference Board, is the main source of estimates of hours worked per person employed that are somewhat comparable across countries. These series are adjusted to reflect most sources of variation in hours worked (contracted length of the workweek, statutory holidays, paid vacation and sick days, days lost due to strikes) and are consistent with aggregate measures of output. The TED dataset covers a large set of developed and developing countries, in many cases starting in the 1950s, and is currently the benchmark source of data for analysis of trends in hours worked across countries[2].

We construct a dataset of quarterly indicators of hours per worker as follows. For all countries, we first collect official series of hours per worker that are consistent with the national accounts from national agencies[3]. We then extend the official series using measures of hours per worker collected from the International Labor Office (ILO) and from the OECD Main Economic Indicators (MEI)[4]. Although both publications are constructed primarily using information from establishment surveys, we opted for adopting the ILO series to extend the official series for three main reasons:

(1) The ILO series often measure total hours *actually worked,* and not just paid for;

(2) The ILO series cover the non-agricultural sector (i.e. manufacturing, mining and quarrying, construction, commerce, transport and services) whereas the OECD-MEI series typically cover the manufacturing sector only;

(3) The ILO series have statistical properties in terms of trends and variability closer to the official series, suggesting that the underlying surveys were primary sources used by the national agencies.

[2]See, for instance, Rogerson [2006], Ohanian et al. [2008].

[3]The Japanese series excludes the agriculture sector, so we construct an employment-weighted series using annual levels in this sector as estimated in the EU-Klems database.

[4]In particular, we used several paper issues of the ILO Bulletin of Labor Statistics and the ILO International Labour Review.

We then construct our extended series for hours per worker as follows. For each country i, we estimate an econometric model of the official hours series (h_t^i) as a function of a constant (c), current and lagged values of the ILO hours series $\left(\widetilde{h}_{t-k}^i\right)$, and a time trend:

$$h_t^i = c + \beta_0 \widetilde{h}_t^i + ...\beta_k \widetilde{h}_{t-k}^i + \gamma t + \varepsilon_t^i$$

A growing literature has documented that the volatility of output has declined significantly after 1984 (Great Moderation). In this spirit, we only use observations up to 1984Q4 to estimate this model to document the behavior of labor input before and after 1984. We select the parameter governing the lag length (k) using standard information criteria (Akaike and Schwarz) and perform Lagrange Multiplier tests on the residuals to test whether the residuals are white noise. Using the coefficient estimates, we then extrapolate the official hours series backwards to the early1960s. This estimation procedure is applied to Australia, Canada, France, Germany, Italy, Japan, Norway, and Sweden. Since the official series for Austria, Finland, Ireland, and Korea start after 1984, we use the entire sample to extrapolate the official series for these countries. No estimation is applied to the United States (the BLS series we use begins in 1947) and the United Kingdom (for which only the official series, which starts in 1971, is available)[5].

Finally, we use Denton's (1971) method to adjust our constructed quarterly indicators with the TED values. This method minimizes the (weighted) adjustments imposed on the constructed quarterly indicator subject to the constraint that the sum of the quarterly adjusted series equals the value of the annual TED series. Specifically, we chose the weigthing matrix in order to minimize the distance between the growth rates of the adjusted and the indicator quarterly series, so that no discontinuity emerges at the end of each year as a result of the adjustment[6]. The table below presents the countries and their time periods

[5] Eurostat produces a series of hours per worker in Spain which starts in 1995. However, we were not able to find consistent survey data covering the previous years. Thus, we opted to include Spain only in the analysis of the Great Recession.

[6] This would be the case if we were to choose to simply allocate *pro rata* the discrepancy in a given year in each quarter (i.e. the weigthing matrix is the identity matrix). For a more articulated discussion on the

considered in our sample.

Table 1. Hours per Worker: Sample

Australia	1970-2010	Italy	1960-2010
Austria	1965-2010	Japan	1960-2010
Canada	1960-2010	Korea	1970-2009
Finland	1960-2010	Norway	1960-2010
France	1960-2010	Sweden	1975-2010
Germany	1960-2010	UK	1971-2010
Ireland	1960-2010	U.S.	1960-2010

Other data

Data on employment, unemployment and population aged 16-64 are from collected from national statistical offices and the OECD-Economic Outlook database. We construct labor force participation as the sum of employment and unemployment. Our wage series are (nominal) total compensation as constructed from the National Accounts and are obtained from the OECD. We first divide these series by total hours so as to obtain a measure of nominal compensation per hours and then deflate them using the country-specific GDP deflators.

National accounts series for nominal variables (output, consumption, public consumption, and investment) are from the OECD-Economic Outlook and are deflated using their specific price deflator.

3 Descriptive Statistics

This section presents volatility and correlation measures of our constructed hours work with other variables and compares them to employment. We construct total hours worked (H_t)

implications of alternative weighting matrix, see Denton (1971). For a broader discussion about interpolation methods, the reader is invited to check the Handbook of Quarterly National Accounts Compilation. Incidentally, the BLS uses this methodology to derive quarterly estimates of U.S. manufacturing output.

as the product of average hours worked per worker (h_t) and employment (E_t), normalized by the size of the population aged 15-64 years old (P_t).

$$H_t = \frac{h_t}{\overline{h}} * \frac{E_t}{P_t} \tag{1}$$

Since we are also interested in the role of the intensive and the extensive margin in response to business cycle shocks, we further decompose the employment rate into the product of the labor force participation rate (LFP_t) and the employment to labor force rate (i.e. one minus the unemployment rate u_t). That is,

$$\begin{aligned} H_t &= \frac{h_t}{\overline{h}} * \frac{E_t + U_t}{P_t} * \left(1 - \frac{U_t}{E_t + U_t}\right) \\ H_t &= \frac{h_t}{\overline{h}} * LFP_t * (1 - u_t) \end{aligned} \tag{2}$$

Throughout the analysis, statistics refer to the first difference of the natural logarithm of the series, as often reported in the empirical literature[7].

3.1 Total Hours: Volatility and Correlation

Table 2 presents the volatility of total hours worked and the volatility of output, together with the ratio between the two volatilities, for G-7 countries (Canada, France, Germany, Italy, Japan, the U.K., and the U.S.) plus the mean and the median of the distribution of countries contained in our dataset. The bottom panels of the table present these same statistics for the pre- and post-1984 periods.

[Insert Table 2 here]

[7] See, for instance, Gali' [1999], Fisher [2007], Gali' and Gambetti [2010], Barnichon [2010]. Results using HP-filter and BP-filter are also available upon request.

Table 2 shows that, across countries, total hours are as volatile as output over the business cycle, thus confirming the typical pattern documented in U.S. data. As documented in Gali' and Gambetti [2010] (GG hanceforth), the absolute volatility of total hours in the post1984 period has declined in the United States, but it has increased relative to the volatility of output. Among G-7 countries, we find that this pattern is also present in Canada, France, Italy, and, to a lesser extent, in Germany, but not in Japan and the United Kingdom. More generally, the volatility of total hours across countries has, on average, increased *both* in absolute terms and relative to output. Since GG interpret the U.S. evidence as consistent with an increase in labor market flexibility, our findings suggest that this explanation should be tested against the various outcomes observed across countries.

Different labor market institutions, such as firing costs, generous unemployment benefits, but also work-sharing arrangements, are likely to affect the extent to which firms adjust labor input along the extensive or the intensive margin. To shed some light on this issue, we further decompose the extensive margin into changes in labor force participation and changes in employment relative to the labor force (i.e. one minus the unemployment rate). Then, we calculate what fraction of the variance of the (first difference of the logarithm of) total hours can be accounted for by changes in hours per worker, changes in labor force participation rate, and changes in the employment to labor force rate. Table 3 presents the result of this calculation.[8]

[Insert Table 3 here]

Two striking facts emerge. First, the adjustment in labor input across countries is, on average, equally distributed between intensive and extensive margin. This result is in sharp contrast with the standard characterization of labor market dynamics obtained by looking at U.S. data, where about one third of the volatility of total hours is accounted

[8] We allocate the sum of all covariance terms equally among the three terms so that the share sum up to one.

for by changes in hours per worker, and two-thirds by employment[9]. Second, the intensive margin has, quantitatively, become more important over time, with changes in hours per worker accounting for almost 65 percent of the variance of total hours in the post-1984 period. However, the contribution of changes in the employment to labor force ratio to the variance of total hours has remained nearly constant, whereas changes in and out of the labor force have become less responsive to cyclical conditions. Overall, these findings are consistent with the idea that firing costs and other labor market rigidities vary to a great deal across countries and their economic relevance has, on average, increased over time, thus limiting the ability of firms to vary employment levels over the cycle. All told, these two facts also suggest that the unemployment rate might be a poor indicator of labor market conditions outside the United States, thus warranting a more general attention to the response of total labor input to business cycle shocks.

We next analyze how the cyclical properties of total hours vary across countries and over time in terms of comovement with output and between the extensive and the intensive margin. Chart 1 presents correlation of total hours with output over the whole sample (panel a) and in the pre- and post-1984 period (panel b). Total hours appear to be procyclical, as typically implied by general equilibrium models, but the magnitude of this correlation varies significantly across countries. In particular, total hours are procyclical in Germany and the United States, but essentially acyclical in Italy and Japan. The average correlation with output is about 0.3, lower than typically reported in the literature. Over time, total hours have become somewhat more correlated with output in the post-1984 period, but the increase is marginal. Interestingly, this correlation has actually declined in the United States (see also GG on this observation) and in all other G-7 countries excluding Canada and France. In Japan, the correlation between total hours and output has actually turned slightly negative.

[9]These figures for the United States are reported, among others, in Kydland [1995], Cho and Cooley [1994], Hall [2007].

[Insert Chart 1 here]

Turning to the intensive and extensive margin (panels c and d) we note two important patterns. First, hours per worker and employment are only weakly correlated, suggesting the timing of the adjustment between the two margins is not contemporaneous. Second, this correlation has weakened significantly over time, becoming even negative in France, Germany, and Italy.

3.2 Labor Productivity: Volatility and Correlation

We construct series for labor productivity as the ratio between real output and total hours and present its properties across countries and over time. As shown in Table 4, labor productivity tends to be slightly more volatile than output, with the average value for the ratio of volatilities near 1.2. Among G-7 countries, productivity is more valatile than output in France, Italy, and Japan, and less volatile in the remaining countries. As documented in GG, the volatility of labor productivity in the United States has fallen significantly during the Great Moderation, but it has in increased relative to output volatility.[10] We find that this is the case in our sample of countries as well, with notable expection being Japan and, to a lesser extent, Germany, where the absolute volatility has increased overtime. In sum, our evidence suggest that the Great Moderation has been associated with an overall decline in the volatility of productivity but an increase in the volatility of total hours. Both variables have actually become more volatile than output in the post-1984 period. Since a proportional reduction in the variance of the shocks generating fluctuations would have preserved relative volatilities, our evidence is consistent with the hypothesis that the Great Moderation was not due to "good luck". Yet, the variety of outcomes observed across countries in terms of changes in absolute volatilities and magnitude of these changes warrant a more systematic investigation of the structural changes proposed in the literature.

[10] We note that in our data the increase in the U.S. volatility of labor productivity is less marked than in the GG's dataset. This difference might be due to the fact that we use measures of output and total hours for the whole economy, whereas GG use series that refer to the nonfarm business sector only.

[Insert Table 4 here]

In the U.S. data, it is a well-established fact that labor productivity and total hours are weakly correlated, a feature of the data that is difficult to account for in a standard real business cycle model à la Kydland and Prescott. Benhabib et al. [1991] show that a model that incorporates home production is able to reproduce the low correlation between hours and labor productivity. Christiano and Eichenbaum [1992], on the other hand, consider shocks to government expenditure, and the wealth effect associated with these shocks, as a key mechanism to account for this correlation. In addition, GG document that this correlation has been falling over time and the evidence provided in Barnichon [2010] is also consistent with this finding. GG concludes that the change in the productivity-hours correlation and in the volatility of hours over time are clearly inconsistent with a strong version of the good luck hypothesis to explain the Great Moderation (i.e. the variance of all shocks affecting the cycle has experienced a roughly proportional fall). Similarly, the cyclical properties of labor productivity vis-à-vis output bear important implications on the nature of fluctuations driving business cycles.[11] Thus, since the sign of these correlations and their time changes have received much attention, it is important to explore what the international data imply for these features of the data. Chart 2 summarizes the evidence on these moments.

[Insert Chart 2 here]

We find that, over the period 1960-2007, labor productivity has been procyclical, with the average correlation around 0.6 (panel a). Among G-7 countries, productivity tends to be strongly procyclical in European countries and Japan, whereas in the United States and Canada this correlation is in line with the average value. However, this correlation

[11] Gali' and van Rens [2010] argue that a reduction in labor market frictions can account for these facts together with the increase in the volatility of real wages that occurred during the Great Moderation.

has generally weakend over time (panel b), thus suggesting that the evidence provided in GG and Gali' and Van Rens [2010] (GVR henceforth) applies to a larger set of advanced economies. Nevertheless, we note that even in the post-1984 sample, labor productivity remains procyclical.

The negative correlation between labor productivity and total hours, found in the U.S. data, is also a robust feature across countries. We find that this correlation is negative for the United States (nearly -0.25) and the cross-country average is even more negative (-0.45). Among G-7 countries Italy stands out as an outlier on the low end of the distribution (-0.6) while Germany on the high end (-0.13). We also provide evidence that this correlation has declined in the post-1984 period, in accordance with the U.S. evidence. The decline has been particularly pronounced in the United Kingdom, where the sign of this correlation has indeed switched sign.

3.3 Real Wages, Total Hours, and Labor Productivity

So far we have focused our attention on describing the behavior of total hours worked and labor productivity across countries and over time making use of the new dataset constructed for this analysis. We next turn to the cyclical patterns observed in real wages and the interaction between labor input and wages.

[Insert Table 5 here]

As shown in Table 5, real wages, constructed as real total compensation per hour, are quite volatile over the cycle as they fluctuate more than output, labor productivity, and total hours worked in almost all countries. Among G-7 countries, the absolute volatility of real wages has increased over time only in the United States, as also reported in GVR, whereas it has declined dramatically in France, Italy, and the United Kingdom. On average, the absolute volatility of real wages has edged down across countries.

Perhaps more remarkable is the observation that real wages have become more volatile *relative* to output and, to a lesser extent, labor productivity in the post-1984 period. Once again, there is quite a bit of variation across countries, with the Great Moderation in Italy, the United Kingdom, and the United States associated with sharp increases in real wage volatility relative to output volatility. Interestingly, the volatility of wages relative to total hours worked has declined significantly after 1984, consistent with our earlier finding that hours have become much more volatile during the Great Moderation. Canada and the United States stand out as countries where the volatility of wages relative to total hours has instead increased.

[Insert Chart 3 here]

The cyclical properties of wages are presented in Chart 3. We note that wages are acyclical, with the correlation with output even falling over time (top panels). Along this dimension, the variation across countries is also limited. The correlation with hours, however, is strongly negative across countries, with France, Italy, and the United Kingdom standing out. In the post-1984 period this correlation has, on average, become more negative. Finally, wages tend to closely follow the behavior of labor productivity and this relationship has generally strengthened over time, with the notable exception of the United States.

4 Business Cycle Diagnostics

4.1 The Diagnostic Framework

Cole and Ohanian (2002) and Chari, Kehoe, and McGrattan (2007) present a diagnostic methodology for broadly evaluating the classes of theories that may potentially account for fluctuations. This process has been used implicitly in one form or another by much of the real business cycle literature, including Kydland and Prescott (1982), and in general

equilibrium analyses of fluctuations that focus on channels other than productivity, including Hall (1997), Cole and Ohanian (2004), Gali', Gertler, and Lopez-Salido (2007), Shimer (2009), and Mulligan (2010).

This process involves using time series data on output, consumption, investment, and labor input to measure wedges from the first order conditions in a parameterized optimal growth model, and then use those wedges as diagnostics for constructing economic theories of fluctuations. This section uses this analytical framework to measure such wedges in two ways. For the sample of OECD countries considered, we first construct these wedges using the standard measure of employment as labor input, and we then compare them to wedges constructed using the measures of hours worked reported earlier in this paper as the measure of labor input.

The theoretical framework is given as follows. Preferences are:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \{\ln(C_t) + \phi \ln(1 - L_t)\}.$$

The technology, resource constraint and the law of motion for capital are given by:

$$AK_t^{\theta} L_t^{1-\theta} = Y_t = C_t + I_t + G_t,$$

$$(1 + g)K_{t+1} = (1 - \delta)K_t + I_t,$$

where the variables are, respectively, per-capita measures of consumption (C), fraction of time devoted to market activities (L), capital stock (K), real output (Y), investment (I), and government spending (G). The variable A denotes total factor productivity, and g is the exogenous growth rate of technology, respectively. All per-capita variables are detrended at a two percent annual rate. The appendix describes the sources and construction of these data.

The parameters are chosen as follows. We set β to 0.99, $\theta = 0.36$, $\delta = .0175, g = .005$,

and ϕ is chosen so that steady state hours worked is 1/3 of the time endowment. Typically, this framework is used to construct four deviations, or wedges: (1) a productivity wedge, which is the Solow Residual, (2) a labor wedge, which is the difference between the marginal rate of substitution between consumption and leisure and the marginal product of labor, (3) a capital market wedge, which is the difference between the intertemporal marginal rate of substitution and the return to capital, and (4) a resource constraint wedge that measures changes in the allocation of output between consumption, investment, and government spending. We will focus on productivity and labor wedges as these are typically the most important quantitatively in terms of accounting for fluctuations. These deviations are given as:

$$\begin{aligned} Z_t &= \frac{Y_t}{AK_t^{\theta}L_t^{1-\theta}} \\ X_t &= \frac{(1-\theta)(Y_t/L_t)(1-L_t)}{\phi C_t} \end{aligned}$$

For the U.S., we measure these wedges for all NBER recession dates from 1960 through 2007. For other countries, we measure the deviations using recession dates between 1960 and 2007 identified by the Economic Cycle Research Institute (ECRI), who use a methodology to date recessions that is very similar to that of the NBER.

For the 2008-09 recession, we measure these wedges for all countries using common dating, from 2008:1 - through 2009:4**,** which is the hours trough of the U.S. recession**.** We use this trough dating convention because of our interest in the evolution of labor input, and because labor continues to decline significantly following the NBER trough date. (For other NBER recession trough dates, labor input is closer to its trough value).

This approach will allow us to compare our findings to those of Ohanian (2010), who measured these deviations in the U.S. using both hours and employment as labor input, but for the other G7 countries (Canada, France, Germany, Italy, Japan, and the United Kingdom) used just employment as hours were unavailable. Note from these equations that

the two alternative measures of labor input affect TFP, and in particular, the labor wedge.

We conduct separate analyses for the Great Recession, and for all other recessions. For each of these analyses, we make two comparisons. We first measure the size of labor and productivity distortions across countries using both employment and total hours worked. To understand the relative importance of these deviations for fluctuations, we compare their size to average trough recession levels of output and employment, and we then measure the relative contributions of productivity and labor deviations by simulating the model economy with each deviation individually, and measuring the fraction of output and labor change accounted for by each distortion.

4.2 Cross-Country Differences in Employment Protection and Implications for Diagnostics

Before turning to the findings, we note that this collection of countries has very different labor market institutions and regulations that are broadly defined as *employment protection legislation*. The OECD produces employment protection rankings for OECD countries that measures the strength of these policies, and we summarize the OECD's ranking here (OECD, 2004). The OECD index is based primarily on (i) the strength of protection of permanent workers against individual dismissal, (ii) the specific requirements for collective worker dismissal, and (iii) regulations on temporary employment contracts.

Several of the European countries studied here have relatively high levels of employment protection. Specifically, Spain ranks 4th highest in protection (out of 28 countries), while France is 6th, Sweden is 7th, Norway 8th, and Germany is 10th. At the other end of the scale, the UK is 27th out of 28 countries, and moreover has employment protection far below that of the other countries, and the U.S. has the least amount of employment protection, and is ranked 28th.

These large cross-country differences in employment protection indicate large differences in hiring and firing costs across countries, and thus provides an interesting way to interpret

the findings we present below. Specifically, higher firing costs decrease the incentive to cut workers during recessions, and at the same time, increase incentives to reduce hours per worker in order to reduce labor input. This suggests we should observe particular cross-country patterns in these deviations, including that the difference between hours-based and employment-based labor deviations should be considerably larger for much of Western Europe than for the United States and the UK.

4.3 Labor and TFP Wedges in OECD Recessions: 1960-2007

We first compare the size of recessions across countries to help understand the relative size of the labor and productivity wedges we present below. Table 6 shows average trough levels for real GDP and labor (both employment and hours) for several countries.

[Insert Table 6 here]

The data indicate that U.S. recessions were somewhat less volatile than European recessions before 1983, but that U.S. recessions became much less volatile than European recessions afterwards. Specifically, the average U.S. recession trough output level declined by more than half after 1984 (-5.1 percent before 1984, to -2.2 percent afterwards), but the average Western European trough output level was roughly unchanged over this period (-5.3 percent before 1984 and -5.1 percent afterwards). This suggest that the Great Moderation - as measured by recession troughs - was primarily a U.S. phenomenon, rather than an international phenomenon.

We next present statistics on labor and productivity wedges at recession troughs. Table 7 shows the size of labor wedges for all recessions other than the Great Recession, and also splits these recessions into two groups, recessions before the Great Moderation (1984 and before) and those for the Great Moderation (1984 - 2007).

[Insert Table 7 here]

The most striking finding regarding the labor wedges is that the European wedges at recession troughs do not conform to the hypothesized patterns based on both cross-country differences in hiring and firing costs and on the fact that the standard deviation of log-differenced hours per worker is higher in most Western European economies than in the U.S.. The fact that hours per worker is more variable in Europe suggests that their labor wedges should differ considerably when measured using employment versus hours worked.

We begin with the U.S. labor wedges, where firing costs are are the lowest in the OECD's ranking. The U.S. labor wedges constructed using hours worked are about twice as large during recessions compared to those constructed using employment (-2.8 percent compared to -1.2 percent, measured using quarterly data from 1960 - 2007). The hours wedge is about three times as large before 1984 (-3.0 percent compared to -1.1 percent), and there is a small decline in the hours-based wedge during the Great Moderation.

We now compare these U.S. labor wedge values to those from Western Europe. The European wedges feature two suprising patterns. One is that the employment-based labor wedges are much larger than those in the U.S. Specifically, the size of these wedges should be relatively low, ceteris paribus, as high firing costs should limit employment loss during a recession. However, the European employment-based labor wedges are about four times higher than those in the United States before 1984 and even higher during the Great Moderation; the average for Western Europe for 1960 through 2007 is -4.9 percent, compared to -1.2 percent for the U.S. This five-fold difference is also large even after correcting for the fact that Western European recessions on average have been deeper than U.S. recessions.

The second suprising feature of these labor wedges is that the size of the hours-based European wedges seem too small relative to the employment-based measures. To see this, recall that the hours-based wedges in the U.S. are about twice as large as the employment-based wedges. This ratio should tend to be larger in Europe because high firing costs increase the incentive for European firms to adjust labor input more on the intensive margin than the extensive margin (recall findings in Table 3), which is consistent with

higher European firing costs.

We do not observe this pattern among the European wedges, and the difference between the actual and hypothesized pattern is particularly striking during the period when firing costs are relatively high. To see this, note that the hours-based labor wedge in Europe is moderately higher than the employment-based wedge between 1960-1984, –6.6 percent, versus -4.1 percent. However, the employment-based and hours-based wedges are about the same magnitude after 1984 (-7.4 percent compared to -7.3 percent). This similarity between the two wedges is striking because the anecdotal evidence and our measure of EPL suggest that labor market rigidities have probably fallen overtime in Europe (many European countries introduced labor market reforms in the 1990s) and yet the behavior of the European labor wedge has diverged even more from the U.S. labor wedge.

These European recession wedge results are puzzling, both from the perspective of the incentives associated with firing costs and the fact that the importance of the intensive margin is higher in Europe. To resolve the observation that the volatility of the intensive margin is higher in Europe, but that hours-labor wedges are relatively small, first note that the volatility statistics on hours, employment, and hours per worker, reported earlier were calculated for all time periods, whereas the labor wedges are those for peak-to-trough calculations. We therefore constructed the labor wedge for all dates, and constructed the standard deviation of both hours and employment-based wedge measures.

These statistics suggest that the reason that the European hours-based and employment-based wedges are so similar is because the relative share of labor adjustment between hours and employment during recession episodes are markedly different than during expansion episodes. Specifically, the standard deviation of the log change in the hours-based labor wedge in Western Europe measured during both recessions and expansions after 1984 is about 40 percent higher than the employment-based wedge, compared to a difference of about 18 percent in the U.S. This suggests that relatively less adjustment in labor input takes place on the intensive margin during ECRI-dated recessions than during other times.

Before turning to TFP, we finally note that the labor wedge is countercyclical in most countries, thus confirming that standard competitive models would underpredict the business cycle fluctuations observed in hours worked, given the measured consumption to output ratio. Yet, as extensively discussed in Shimer [2010], standard search frictions models as in Mortensen and Pissarides (1994), which are the starting point of most research on imperfectly competitive labor markets, would also have problems in accounting for this property of the data. These models, in fact, deliver a labor wedge that rises in booms and falls in recession, which is counterfactual. Future research should then provide more insights in explaining why the labor wedge is countercyclical and what accounts for the differential behavior in the labor wedge across countries.

Table 8 compares TFP wedges across countries. For the U.S., since hours are more variable than employment, TFP declines more during recessions for employment-based labor than for hours-based labor (-2 percent for hours-TFP compared to -2.8 percent for employment), and both measures decline considerably during the Great Moderation to -0.9 percent and -1.4 percent, respectively. These 50 percent declines in cyclical U.S. TFP is consistent with the findings of Arias et al (2007), who report a similar drop in TFP volatility and that such a decline can approximate the decline in the volatility of U.S. output and hours.

[Insert Table 8 here]

In comparison with other countries, before 1984, Western Europe featured smaller recession TFP declines for both hours-based and employment-based measures of labor input, despite the fact that European recessions were somewhat deeper. However, this pattern of relatively small Western European TFP declines is reversed during the Great Moderation, as the large moderation in U.S. TFP decline is not mirrored in Europe. Specifically, both hours-based and employment-based measures of European TFP are higher than their U.S. counterparts after 1984 (-1.9 percent for hours, -1.8 percent for employment for Western

Europe, compared to -0.9 percent and -1.4 percent, respectively). These statistics also indicate that the Great Moderation was primarily a U.S. event - that largely involved less volatile productivity - and not an event that had a systematic impact in Europe.

4.4 OECD Labor and TFP wedges and Implications for the Great Recession

We now turn to constucting these statistics for the Great Recession, with a focus on comparing the findings to those of Ohanian (2010). Ohanian finds that the productivity and labor wedges differ remarkably between the U.S. and the other advanced countries during the Great Recession. Specifically, he shows that the U.S. Great Recession is almost entirely due to a very large decline in labor input that is associated with an historically large labor wedge, and that productivity is on trend during this recession. In contrast, the recessions in other G7 countries are virtually the opposite of that in the U.S., as other G7 recessions are almost entirely due to negative productivity wedges, with only small employment declines and with no quantiatively important labor wedges.

These very different patterns for the Great Recession between the U.S. and the other G7 countries led Ohanian to suggest that the underlying source and/or propogation mechanisms for the Great Recession may have been very different between the U.S. and these other countries, and that these different patterns pose a challenge for the widely held view that all of these recessions were the result of similar banking crises that operated through the same economic channels. But Ohanian's analysis for the other G7 countries was based entirely on employment. We now assess whether quantitatively import labor wedges emerge in the other countries when hours rather than employment are used as labor input.

[Insert Table 9 here]

Table 9 shows output, labor, labor wedge and productivity wedge for the Great Recession across countries. There are two key findings. First, when we use total hours as

labor input instead of employment in constructing the labor and productivity wedges in non-U.S. countries we find that the size of labor wedges for Western Europe is essentially unchanged. Specifically, note that the U.S. hours-labor wedge is nearly -10 percent at the trough of U.S. hours worked in the Great Recession, while the hours-labor wedge is only -0.7 percent on average for Western Europe and is little different from its value measured using employment (0.1 percent).

The second key finding is that the European labor wedges - measured using hours or employment - are remarkably small during the Great Recession when compared to their size during previous recessions described above. To see this, we compare the relative size of labor wedges and output loss during the Great Recession to all other recessions. The average peak-to-trough hours-labor wedge for Western Europe between 1960 and 2007 was about 6 percent, when output fell about 5 percent. These numbers for the Great Recession, in contrast, are about 1 percent and 9 percent, respectively. This implies that if the pre-Great Recession relationship between the labor wedge and output was also operative during the Great Recession, then the hours-labor wedge would have been around 11 percent (given the 9 percent output decline), more than an order of magnitude bigger than it was.

Not surprisingly, the labor wedge accounts for very little of the Great Recession in Europe. Table 10 shows the percentage of trough output and labor accounted for by the model in response to the labor wedge and the productivity wedge, using both employment and hours worked as labor input.[12] While the U.S. hours-labor wedge accounts for almost all of U.S. output, and more than the full decline in hours worked, the European hours-labor wedge accounts for very little of the drop in European output and hours. In contrast, productivity in the U.S. explains only about 30 percent of the drop in output, and almost none of the drop in hours in the U.S., whereas productivity overaccounts for output and hours on average in Western Europe.

[Insert Table 10 here]

[12] We label these experiments as Model 1-4.

These large differences in the size of labor and productivity wedges, and their relative contributions to the Great Recession across countries, pose a challenge for the common view that the coincident recessions across countries in 2008-2009 were the consequence of very similar banking crises that depressed economies through very similar economic channels and forces. Instead, these results point to considerable differences between the U.S. and Western Europe, and suggest that different economic forces were operative in the U.S. compared to much of Western Europe.

Moreover, the fact that both hours and employment labor wedges are about an order of magnitude smaller than their normal recession size during the Great Recession in Europe raises an additional, and intriguing, puzzle of : why were the dynamics of employment and hours per worker so much different during the worst postwar European recession compared to other recessions?

While the results indeed indicate that the U.S. is an outlier compared to much of Western Europe, Table 9 and Table 10 also presents the labor and productivity wedges for some OECD countries that were not analyzed by Ohanian (2010). In particular, both Spain and Ireland have very large labor wedges (around -15 percent), measured using either hours or employment. This similarity between the U.S., Spain, and Ireland suggests a new avenue for understanding cross-country experiences. One possibility relates to the housing market. Specifically, some economists have argued that in the U.S., very large housing price declines, coupled with government policies designed to cushion the impact of falling prices on borrowers, including mortgage modification programs, changed the incentives for unemployed individuals to take new jobs or for homeowners to relocate from relatively depressed areas to areas with better job prospects (see Mulligan, 2008, and Herkenhoff and Ohanian, forthcoming).

While it is beyond the scope of this paper to pursue this idea in detail, we do present some limited evidence on the relationship between the labor market and housing. Chart 4 shows percentage changes in house prices and construction employment for the U.S.,

Canada, Western Europe (as defined in the previous tables), Spain, and Ireland.[13] It is interesting that the three countries which have large labor wedges - the U.S., Spain, and Ireland - have also experienced large declines in house prices and construction activity.

[Insert Chart 4 here]

5 Summary and Conclusions

Cyclical labor fluctuations are a central focus of business cycle research, but this research has been significantly limited by the fact that typically only employment, rather than total hours worked, is available for many OECD countries. This paper has constructed quarterly time series of total hours worked for 14 OECD countries covering the past 50 years of history, with a focus on constructing hours that are consistent with national income and product account constructs. These hours measures provide new labor data that can be used by others studying international fluctuations.

We present empirical regularities across countries that stand in sharp contrast to many common views about cyclical labor market dynamics. First, we show that for several countries employment is a very poor proxy for cyclical labor input, and consequently provides poor measures of productivity, as about 50 percent of labor adjustment occurs along the intensive margin. Another finding is that employment fluctuations in much of Western Europe appear to be much too high compared to the U.S., given much higher hiring and firing costs in Europe. And given the large fluctuations in European hours, employment-based labor wedge fluctuations in Europe are too high, and hours-based labor wedge fluctuations are too low. Our findings also have implications for the international Great Recession.

[13] We obtain house price series from the OECD. However, there are some issues about the comparability of these measures across countries as the underlying methodology adopted by individual countries may vary quite dramatically. For instance, the series for Spain, which is based on appraisals, is believed to underestimate the actual decline in house prices. Similarly, for the United States, the CoreLogic National Price House Index and the Case-Shiller index show, over the same time period, a 35 percent drop in house prices, whereas the OECD series is based on the FHFA index.

Specifically, there is a common view that the Great Recession across countries was the result of very similar responses to very similar banking crises. The findings presented here contrast with that view, as Western European recessions feature very small labor wedges compared to the U.S., measured either with employment or hours, and instead feature much larger productivity shocks than the U.S..

Future research should aim to address these puzzles, with a focus on understanding why the intensive margin adjustment is so small during European recessions, and why labor wedges are virtually non-existant in many European countries during the Great Recession, and why they are so large in the U.S..

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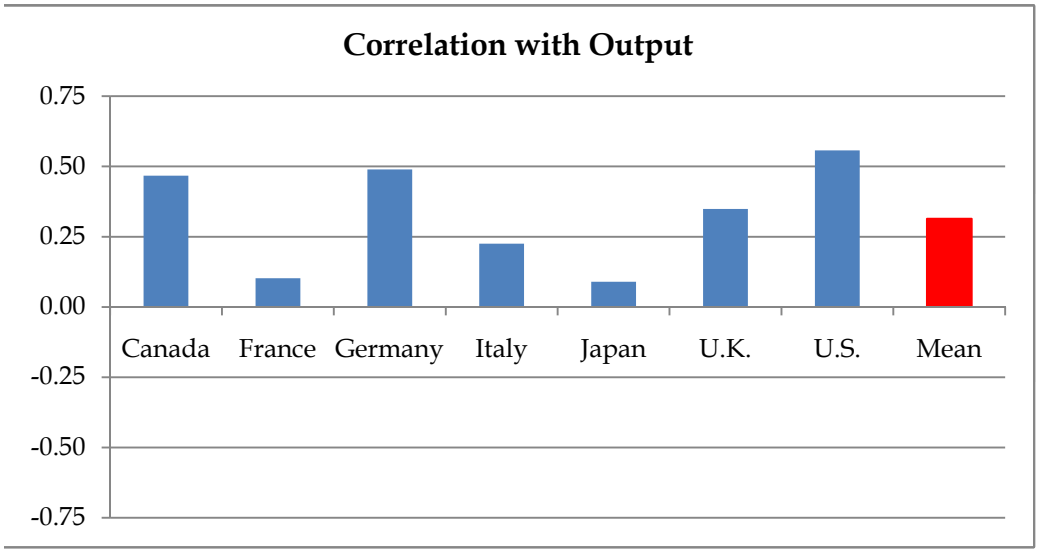
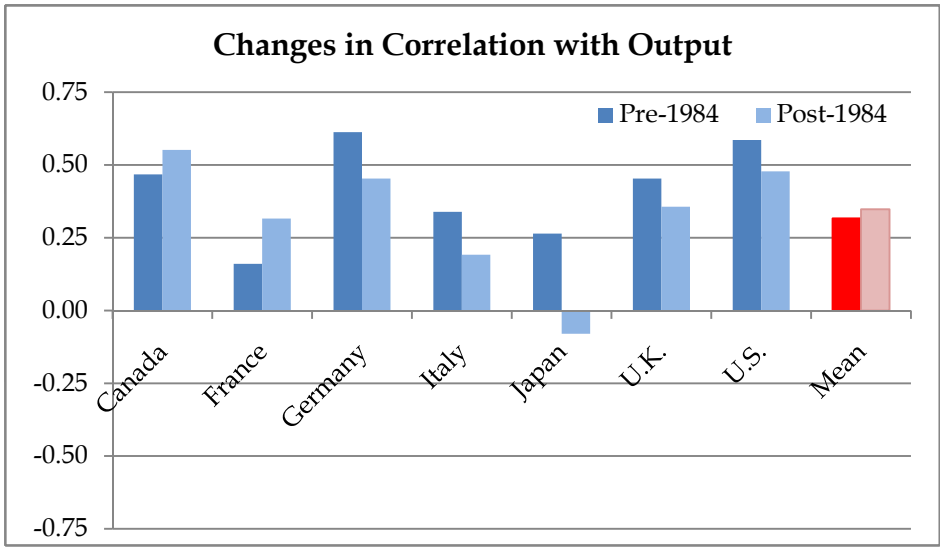
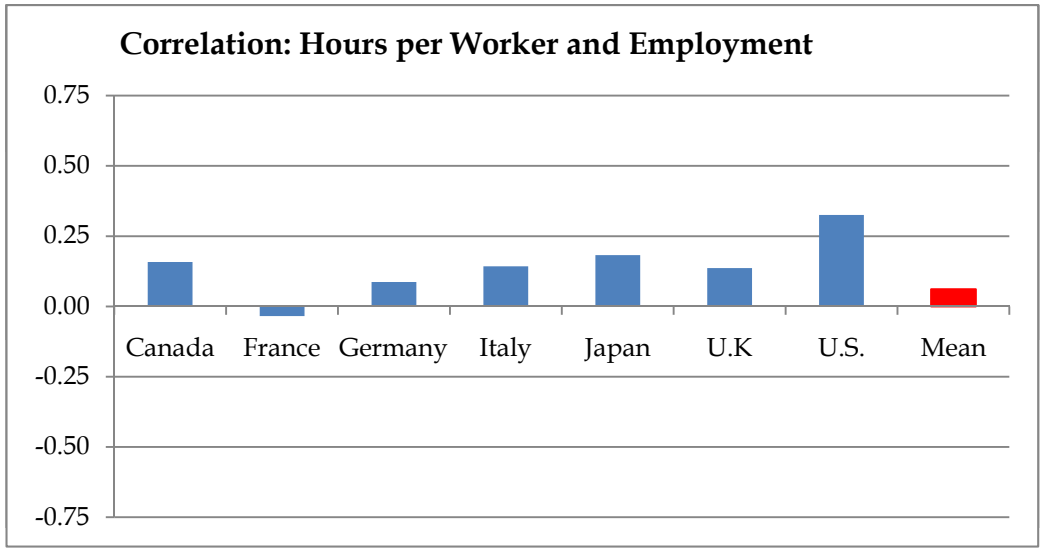
Chart 1. Cyclical Properties of Total Hours Worked







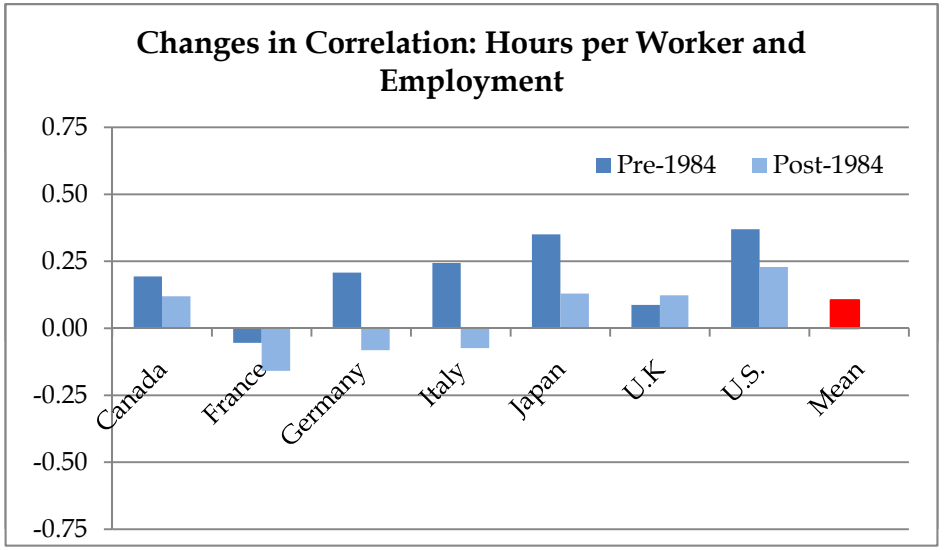
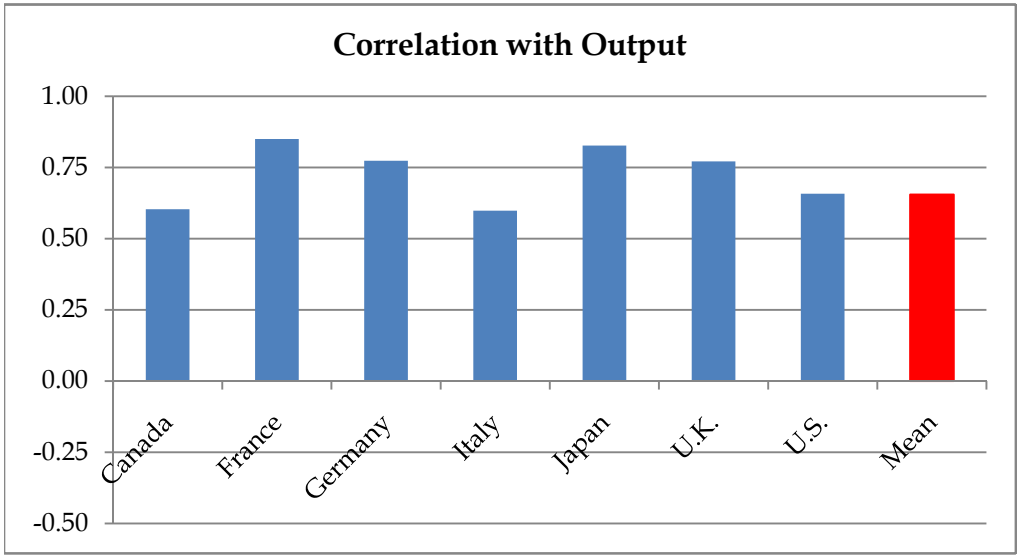
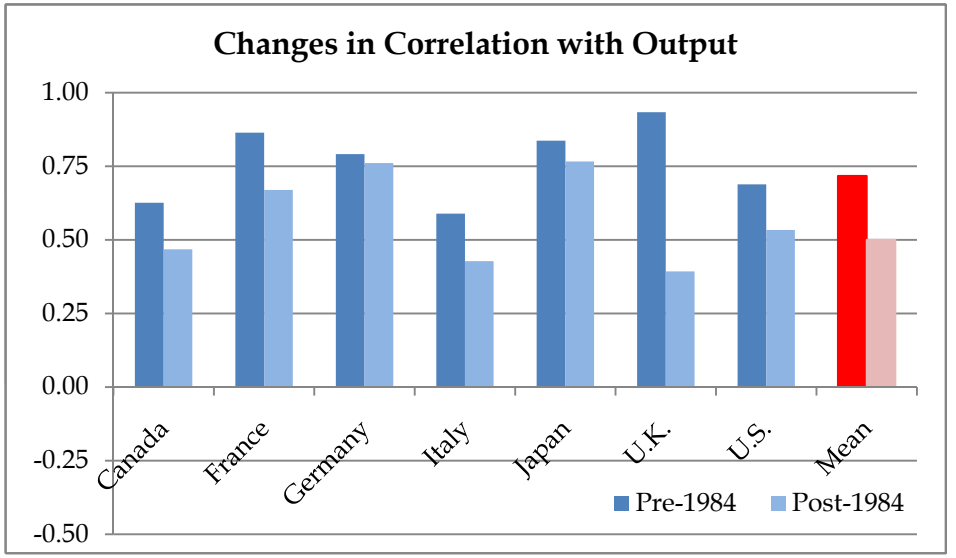
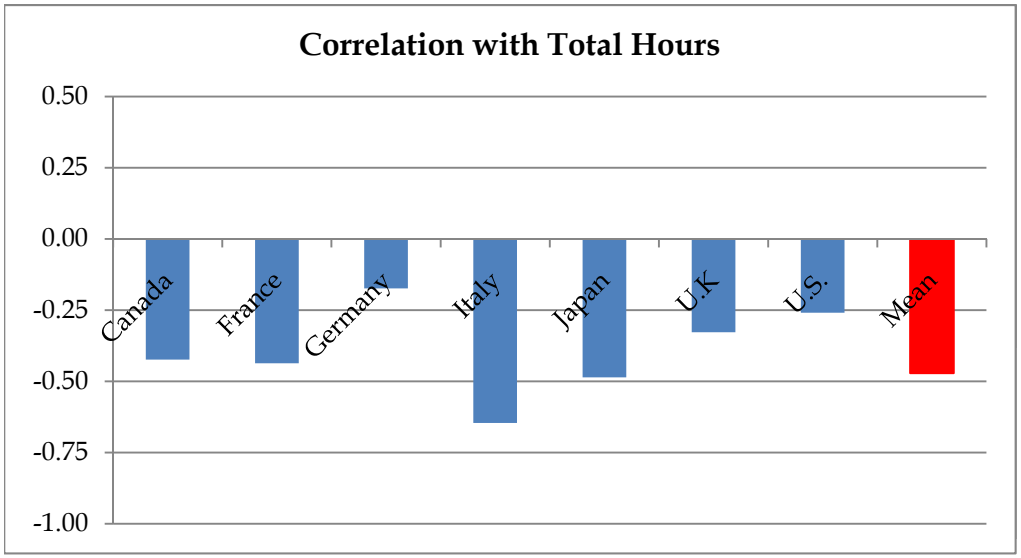


Chart 2. Cyclical Properties of Labor Productivity







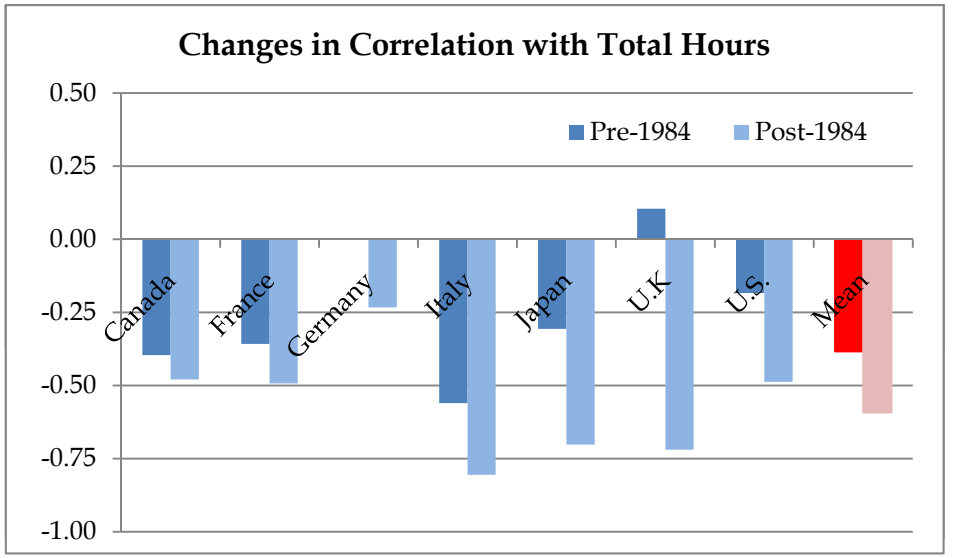
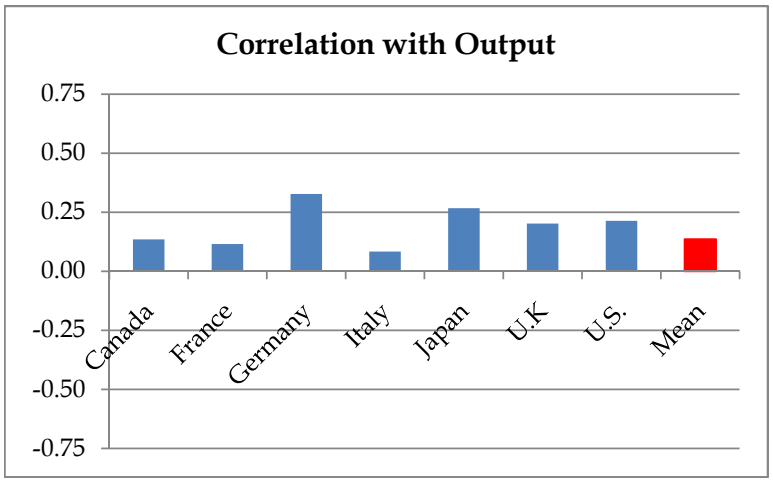
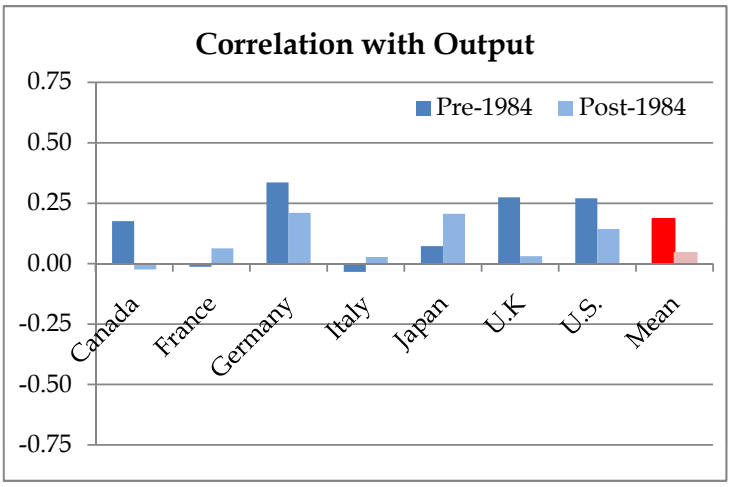
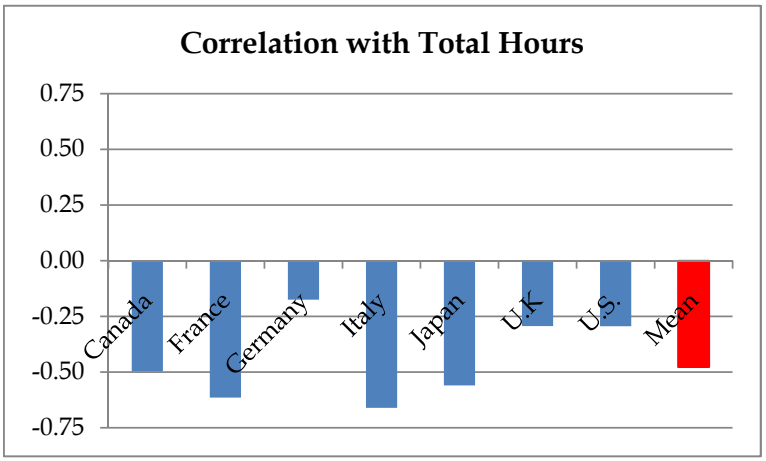
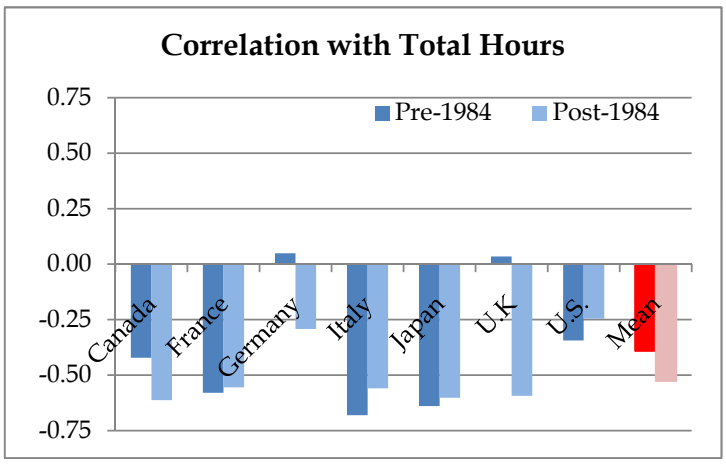


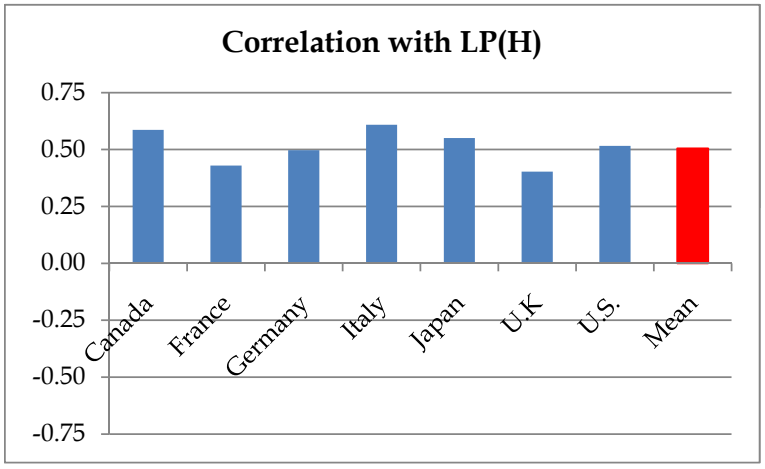
Chart 3. Cyclical Properties of Real Wages











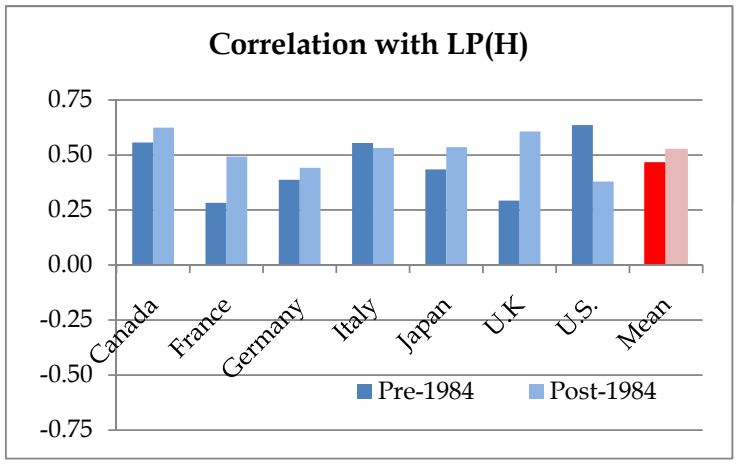
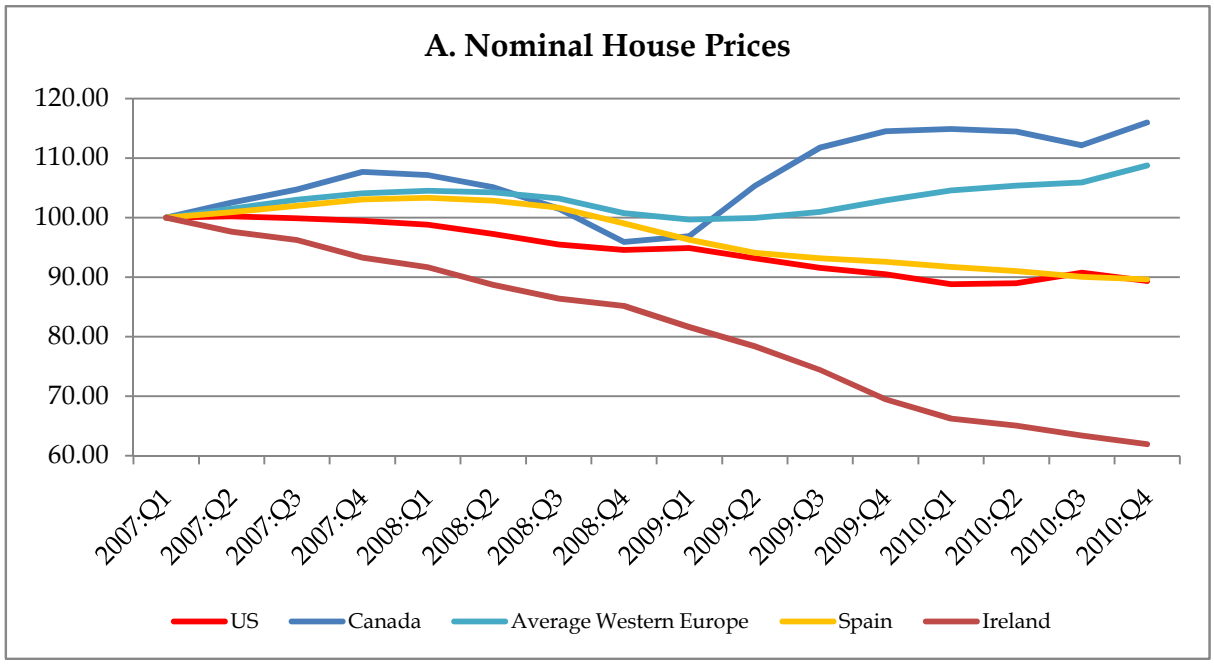


Chart 4. Housing Sector During the Great Recession



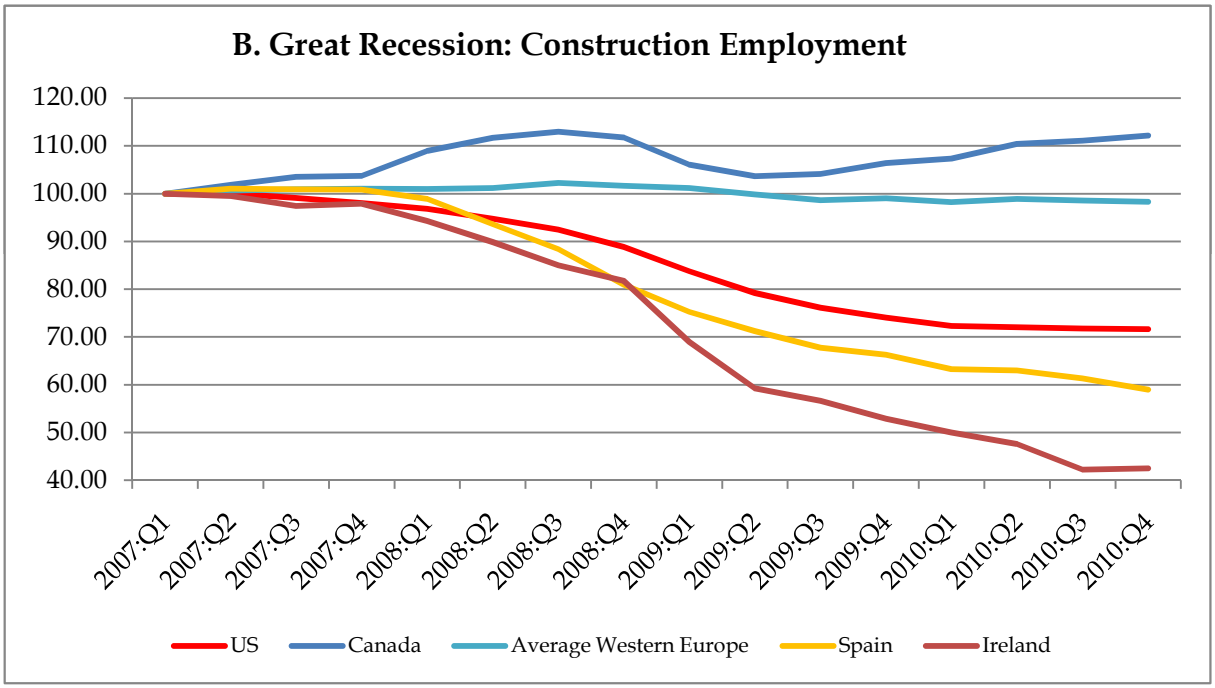


Table 2. Volatility of Total Hours Worked

		CAN	FRA	GER	ITA	JAP	UK	US	Mean	Median
Standard Deviation										
1960:Q1 - 2007:Q4	*Total Hours*	0.76	0.57	0.59	0.98	0.79	0.62	0.66	1.00	0.71
	Output	0.86	0.97	0.92	0.94	1.23	0.95	0.84	1.05	0.96
	Ratio	0.88	0.59	0.64	1.05	0.64	0.65	0.78	0.92	0.74
1960:Q1 - 1984:Q4	*Total Hours*	0.86	0.67	0.61	1.12	0.71	0.49	0.79	0.93	0.75
	Output	1.01	1.24	1.00	1.15	1.24	1.22	1.07	1.18	1.22
	Ratio	0.85	0.54	0.61	0.98	0.57	0.40	0.74	0.78	0.66
1985:Q1 - 2007:Q4	*Total Hours*	0.63	0.38	0.54	0.77	0.87	0.66	0.48	1.03	0.69
	Output	0.63	0.44	0.81	0.51	0.96	0.50	0.50	0.81	0.64
	Ratio	1.01	0.85	0.67	1.52	0.90	1.32	0.97	1.23	1.02

Table 3. Extensive vs Intensive Margin

		CAN	FRA	GER	ITA	JAP	UK	US	Mean	Median
Var(x) Relative to Var(Total Hours)										
1960:Q1 - 2007:Q4	*hours*	0.33	0.34	0.55	0.49	0.67	0.54	0.40	0.54	0.55
	LFP	0.35	0.56	0.21	0.40	0.25	0.19	0.25	0.27	0.25
	Unempl. rate	0.32	0.11	0.24	0.10	0.07	0.27	0.35	0.18	0.16
1960:Q1 - 1984:Q4	*hours*	0.25	0.23	0.54	0.40	0.45	0.33	0.37	0.46	0.42
	LFP	0.42	0.72	0.21	0.48	0.44	0.32	0.25	0.33	0.31
	Unempl. rate	0.34	0.05	0.26	0.12	0.11	0.36	0.38	0.21	0.13
1985:Q1 - 2007:Q4	*hours*	0.50	0.69	0.61	0.73	0.84	0.64	0.49	0.65	0.64
	LFP	0.21	0.09	0.20	0.22	0.11	0.15	0.25	0.19	0.18
	Unempl. rate	0.29	0.23	0.19	0.05	0.05	0.21	0.26	0.17	0.16

Table 4. Labor Productivity: Volatility

		CAN	FRA	GER	ITA	JAP	UK	US	Mean	Median
Standard Deviation										
1960:Q1 - 2007:Q4	*LP(H)*	0.84	1.07	0.82	1.20	1.40	0.91	0.72	1.26	1.05
	Output	0.86	0.97	0.92	0.94	1.23	0.95	0.84	1.05	0.96
	Ratio	0.98	1.11	0.89	1.28	1.14	0.96	0.86	1.19	1.09
1960:Q1 - 1984:Q4	*LP(H)*	0.97	1.31	0.79	1.30	1.26	1.22	0.88	1.31	1.24
	Output	1.01	1.24	1.00	1.15	1.24	1.22	1.07	1.18	1.22
	Ratio	0.96	1.06	0.79	1.14	1.01	1.00	0.82	1.11	1.02
1985:Q1 - 2007:Q4	*LP(H)*	0.60	0.48	0.74	0.84	1.35	0.67	0.50	1.12	0.78
	Output	0.63	0.44	0.81	0.51	0.96	0.50	0.50	0.81	0.64
	Ratio	0.95	1.09	0.92	1.66	1.40	1.34	1.01	1.39	1.22

Table 5. Real Wages: Volatility

			CAN	FRA	GER	ITA	JAP	UK	US	Mean	Median
1960:Q1 - 2007:Q4											
	Absolute STDev*		0.87	0.98	0.92	1.54	1.39	1.16	0.73	1.43	1.27
	Relative to:	*Output*	1.01	1.00	1.00	1.64	1.13	1.23	0.87	1.34	1.26
		LP(H)	1.04	0.91	1.13	1.28	1.00	1.27	1.02	1.18	1.12
		Total Hours	1.15	1.72	1.56	1.56	1.76	1.87	1.12	1.57	1.64
1960:Q1 - 1984:Q4											
	Absolute STDev*		0.92	1.10	0.93	1.72	1.42	1.52	0.70	1.36	1.42
	STDev Relative to:	*Output*	0.91	0.89	0.93	1.50	1.15	1.24	0.66	1.18	1.24
		LP(H)	0.94	0.84	1.18	1.32	1.13	1.25	0.79	1.14	1.16
		Total Hours	1.07	1.65	1.52	1.54	1.99	3.11	0.89	1.81	1.65
1985:Q1 - 2007:Q4											
	Absolute STDev*		0.80	0.48	0.71	1.07	1.11	0.89	0.77	1.27	1.27
	STDev Relative to:	*Output*	1.28	1.08	0.87	2.10	1.15	1.79	1.56	1.59	1.59
		LP(H)	1.35	0.99	0.95	1.27	0.83	1.33	1.55	1.24	1.24
		Total Hours	1.27	1.26	1.31	1.38	1.28	1.35	1.61	1.39	1.39

* Statistics refer to the standard deviation of (the first difference of the logarithm of) real compensation per hour.

Table 6. Output, Hours, and Employment at Trough, Average Deviation from Peak

(1) US (NBER recessions)

	Output	*Hours*	*Empl.*
All recessions (except Great Recession)	-4.3	-3.5	-2.1
Pre-1984 recessions	-5.1	-3.9	-2.3
Post-1984 recessions (except Great Recession)	-2.2	-2.4	-1.6

(2) Other high income countries (ECRI recessions)

	Output					*Hours*					*Empl.*				
	Canada	**France**	**Germany**	**Italy**	**UK**	**Canada**	**France**	**Germany**	**Italy**	**UK**	**Canada**	**France**	**Germany**	**Italy**	**UK**
All recessions (except Great Recession)	-9.1	-3.3	-5.1	-4.3	-7.0	-7.3	-2.7	-5.7	-2.2	-5.2	-6.0	-1.6	-3.6	-2.4	-3.0
Pre-1984 recessions	-9.5	-3.5	-5.4	-4.2	-7.7	-8.0	-3.3	-6.8	-1.5	-4.4	-6.9	-1.9	-3.9	-1.8	-2.3
Post-1984 recessions (except Great Recession)	-8.6	-3.0	-4.8	-5.0	-5.6	-6.6	-1.8	-4.0	-4.6	-6.8	-5.1	-1.3	-3.2	-4.8	-4.5

(3) Average Western Europe: France, Germany, Italy, UK, Austria, Spain, Sweden (ECRI recessions)*

	Output	**Hours**	*Empl.*
All recessions (except Great Recession)	-5.3	-5.0	-3.8
Pre-1984 recessions	-5.6	-5.5	-3.4
Post-1984 recessions (except Great Recession)	-5.2	-5.3	-5.1

(4) Japan, Korea (ECRI recessions)**

	Output		*Hours*		*Empl.*	
	Japan	**Korea**	**Japan**	**Korea**	**Japan**	**Korea**
All recessions (except Great Recession)	-4.8	-7.3	-4.2	-8.1	-1.2	-4.4
Pre-1984 recessions	-5.8		-6.3		-3.3	
Post-1984 recessions (except Great Recession)	-4.5	-5.4	-3.5	-8.1	-0.5	-4.4

*Note: ECRI recession dates only available for the above countries
**Note: Data available from 1990 onwards for Korea

Table 7. Labor Wedge at Trough, Average Deviation from Peak

(1) US (NBER recessions)

	Hours	*Empl.*
All recessions (except Great Recession)	-2.8	-1.2
Pre-1984 recessions	-3.0	-1.1
Post-1984 recessions (except Great Recession)	-2.3	-1.4

(2) Other high income countries (ECRI recessions)

	Hours					*Empl.*				
	Canada	**France**	**Germany**	**Italy**	**UK**	**Canada**	**France**	**Germany**	**Italy**	**UK**
All recessions (except Great Recession)	-8.8	-2.8	-6.3	-2.3	-6.0	-7.7	-1.9	-4.0	-2.3	-3.4
Pre-1984 recessions	-9.4	-3.8	-7.9	-0.2	-4.0	-8.7	-2.4	-4.3	-0.7	-1.3
Post-1984 recessions (except Great Recession)	-8.2	-1.2	-4.0	-8.3	-9.9	-6.7	-1.0	-3.6	-9.1	-7.7

(3) Average Western Europe: France, Germany, Italy, UK, Austria, Spain, Sweden (ECRI recessions)*

	Hours	*Empl.*
All recessions (except Great Recession)	-6.2	-4.9
Pre-1984 recessions	-6.6	-4.1
Post-1984 recessions (except Great Recession)	-7.3	-7.4

(4) Japan, Korea (ECRI recessions)**

	Hours		*Empl.*	
	Japan	**Korea**	**Japan**	**Korea**
All recessions (except Great Recession)	-5.5	-17.4	-0.4	-10.2
Pre-1984 recessions	-9.1		-3.5	
Post-1984 recessions (except Great Recession)	-4.3	-17.4	0.6	-10.2

* Note: ECRI recession dates only available for the above countries

** Note: Data available from 1990 onwards for Korea

Table 8. Productivity Wedge at Trough, Average Deviation from Peak

(1) US (NBER recessions)

	Hours	*Employment*
All recessions (except Great Recession)	-2.0	-2.8
Pre-1984 recessions	-2.4	-3.4
Post-1984 recessions (except Great Recession)	-0.9	-1.4

(2) Other high income countries (ECRI recessions)

	Hours					*Employment*				
	Canada	**France**	**Germany**	**Italy**	**UK**	**Canada**	**France**	**Germany**	**Italy**	**UK**
All recessions (except Great Recession)	-4.7	-1.5	-1.5	-3.3	-3.8	-5.5	-2.2	-2.8	-2.8	-5.2
Pre-1984 recessions	-4.9	-1.3	-0.9	-3.7	-4.8	-5.6	-2.2	-2.8	-3.1	-6.2
Post-1984 recessions (except Great Recession)	-4.5	-1.8	-2.4	-1.8	-1.8	-5.5	-2.1	-2.8	-1.6	-3.3

(3) Average Western Europe: France, Germany, Italy, UK, Austria, Spain, Sweden (ECRI recessions)*

	Hours	*Employment*
All recessions (except Great Recession)	-1.9	-2.8
Pre-1984 recessions	-1.8	-3.2
Post-1984 recessions (except Great Recession)	-1.9	-2.0

(4) Japan, Korea (ECRI recessions)**

	Hours		*Employment*	
	Japan	**Korea**	**Japan**	**Korea**
All recessions (except Great Recession)	-3.1	-1.2	-5.0	-3.6
Pre-1984 recessions	-4.0		-5.9	
Post-1984 recessions (except Great Recession)	-2.8	-1.2	-4.6	-3.6

*Note: ECRI recession dates only available for the above countries

**Note: Data available from 1990 onwards for Korea

Table 9. Great Recession, Deviation from Peak (US hours trough)

	Data			Labor wedge		Productivity wedge	
	Output	*Hours*	*Employment*	*Hours*	*Employment*	*Hours*	*Employment*
US	-7.2	-8.3	-7.0	-9.9	-9.0	-1.4	-2.3
Canada	-8.1	-4.4	-2.9	-2.0	-0.5	-5.9	-6.7
France	-6.7	-2.8	-2.1	0.8	1.0	-5.2	-5.6
Germany	-6.8	0.5	1.7	4.1	6.3	-7.0	-7.8
Italy	-10.8	-5.8	-5.4	-3.5	-3.8	-6.4	-6.6
UK	-10.2	-4.5	-3.1	-3.9	-2.6	-7.4	-8.3
Average Western Europe*	-9.0	-3.2	-2.3	-0.7	0.1	-7.0	-7.5
Spain	-9.0	-8.9	-10.0	-14.0	-16.4	-4.1	-3.3
Ireland	-16.4	-14.4	-13.1	-15.5	-15.6	-8.0	-8.9
Japan	-7.6	-4.2	-0.7	-1.8	4.0	-4.4	-6.6
Korea	-2.7	-2.3	-1.2	-4.6	-2.4	-1.9	-2.6

*France, Germany, Italy, UK, Austria, Finland, Netherlands, Norway, Sweden

Table 10. Great Recession, Deviation from Peak (Hours Trough)

	Data			Predicted, Model 1		Predicted, Model 2		Predicted, Model 3		Predicted, Model 4	
	Output	*Hours*	*Employment*	*Output*	*Hours*	*Output*	*Employment*	*Output*	*Hours*	*Output*	*Employment*
US	-7.2	-8.3	-7.0	-6.8	-9.8	-5.9	-8.7	-2.2	-0.5	-3.5	-0.8
Canada	-8.1	-4.4	-2.9	-1.3	-1.9	-0.3	-0.5	-9.0	-3.1	-10.1	-3.2
France	-6.7	-2.8	-2.1	0.5	0.7	0.7	0.9	-7.9	-2.7	-8.3	-2.6
Germany	-6.8	0.5	1.7	2.6	3.6	4.0	5.4	-10.8	-3.9	-11.6	-3.8
Italy	-10.8	-5.8	-5.4	-2.3	-3.3	-2.4	-3.6	-9.8	-3.5	-9.8	-3.1
UK	-10.2	-4.5	-3.1	-2.5	-3.7	-1.7	-2.5	-11.5	-4.1	-12.4	-4.1
Average Western Europe*	-9.0	-3.2	-2.3	-0.5	-0.7	0.1	0.0	-10.9	-3.8	-11.3	-3.6
Spain	-9.0	-8.9	-10.0	-9.8	-13.9	-11.5	-16.3	-6.2	-2.1	-4.8	-1.5
Ireland	-16.4	-14.4	-13.1	-10.9	-15.7	-10.8	-15.6	-12.6	-4.2	-13.5	-4.2
Japan	-7.6	-4.2	-0.7	-1.2	-1.7	2.5	3.6	-6.8	-2.2	-9.9	-3.0
Korea	-2.7	-2.3	-1.2	-3.3	-4.0	-1.5	-2.2	-2.8	-1.0	-3.9	-1.0

*France, Germany, Italy, UK, Austria, Finland, Netherlands, Norway, Sweden

** Model 1 = labor wedge, hours; Model 2 = labor wedge, employment; Model 3 = productivity wedge, hours; Model 4 = productivity wedge, employment