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JEL refs: E24, E32, J2

Keywords: Germany, United States, aggregate labour adjustment, extensive and intensive margin, business cycle, total hours worked, employment, hours per employee, Great Recession

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Extensive versus intensive margin over the business cycle: New evidence for Germany and the United States

ALEXANDER HERZOG-STEIN AND PATRICK NÜß[1]

18 February 2016

Abstract

This article analyses the relevance of the extensive and the intensive margin of labour adjustment over the business cycle in Germany and in the United States. Previous research has found that, firstly, the extensive margin dominates and that, secondly, the relative relevance of the two margins is of similar magnitude in both countries. This is in contrast with results from the research on the German employment performance in the Great Recession which attributed part of the employment success to the widespread use of instruments of internal flexibility. Our results confirm that generally, the extensive margin is still the dominant margin of labour adjustment over the business cycle in both countries. While our reassessment shows that the relative importance of the extensive and intensive margin for the United States is stable over time, in Germany it is quite volatile over time. In general the intensive margin in Germany is more important than in the United States. However, its actual size depends crucially on the choice of the smoothing parameter of the Hodrick-Prescott Filter. In the Great Recession and the subsequent time period the intensive margin is dominant in Germany independent of the choice of the smoothing parameter. (JEL: E24, E32, J2)

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1. INTRODUCTION

„Consider, for a moment, a tale of two countries. Both have suffered a severe recession and lost jobs as a result — but not on the same scale. In Country A, employment has fallen more than 5 percent, and the unemployment rate has more than doubled. In Country B, employment has fallen only half a percent, and unemployment is only slightly higher than it was before the crisis.
Don't you think Country A might have something to learn from Country B?"

Paul Krugman (New York Times 13 November 2009)

In this quote Paul Krugman talks about Germany and the United States during the Great Recession. According to several studies on the German labour-market performance during that period, this development which Krugman characterized as "Germany's job miracle" is to a remarkable part attributable to companies' widespread use of instruments of internal flexibility. This includes short-time work, overtime and working-time accounts (Herzog-Stein and Seifert 2010, Möller 2010, Burda and Hunt 2011, Herzog-Stein et al. 2013). Calculations of the Institute for Employment Research (IAB) show that the average annual number of working hours per employee was reduced by 50.4 hours (-3.8 %) in 2009 in comparison to 2008. During the same time period, total employment increased by 54 000 employees.

This raises the question about the relative importance of the extensive margin (i.e. fluctuations in employment) and the intensive margin (i.e. fluctuations in hours worked per employee) for business-cycle fluctuations in aggregate hours worked in Germany and the United States. Surprisingly, Merkl and Wesselbaum (2011, pp.805/806) in their comparative study on the relative importance of the intensive and extensive margin for business-cycle fluctuations in total hours worked in Germany and the United States summarized their findings: „*We find that the extensive margin continues to be dominant in the United States (as outlaid by Hansen, 1985). Interestingly, the relative importance of the extensive versus the intensive margin is of similar magnitude in Germany and the United States.*"

Obviously, this result is not in line with the literature on the importance of the intensive margin for Germany's employment success in the Great Recession. Instead, one would expect a difference between the labour market performance in the United States and Germany with respect to the development of employment and unemployment during the Great Recession. If this difference is at least partly attributable to the difference in the use of working-time instruments like short-time work and working-time accounts, then the relative importance of the intensive margin should be larger in Germany than in the United States.

Other results presented in Wesselbaum (2011) on the relative importance of the two margins of labour adjustment for the period 1998q1 to 2010q1 exactly point in this direction. Here, the author reports a stronger intensive margin for Germany. Therefore the aim of this analysis is to shed some light on this alleged paradox in the economic literature. In detail we explore the magnitude and the volatility of the intensive margin over time in Germany and the United States.

The remainder of the paper is organized as follows. The next section reviews the existing literature dealing with labour adjustments over the business cycle. Section 3 provides a description of the data used in our investigation. Section 4 presents the empirical analysis of the relative importance of the intensive and extensive margin for business-cycle fluctuations in total hours worked in Germany and the United States. The results are compared to the earlier findings by Merkl and Wesselbaum (2011). Furthermore, the cyclical and overall stability of the relative contributions of the intensive margin is investigated. In the final section the findings are summarized and some conclusions are drawn.

2. RELATED LITERATURE

Hansen's (1985) seminal work on the relative importance of both margins of labour adjustment, the extensive and intensive margin, in the United States showed on the basis of quarterly data that business-cycle fluctuations in aggregate hours worked were dominated by the extensive margin and not by the intensive margin. According to Hansen's calculations the relative importance of the extensive margin for business-cycle fluctuations in aggregate hours worked in the United States was more than two and a half times larger than that of the intensive margin (Hansen 1985, p. 312).

Interestingly, however, it took a long time until an analysis of the relative importance of the extensive and the intensive margin over the business cycle in European countries and the United States was presented. Only in 2011 Merkl and Wesselbaum's comparative study focusing on Germany and the United States started to fill this gap (Merkl and Wesselbaum, 2011). Although using a different approach than Hansen (1985) to assess the relative importance of the extensive and the intensive margin for the time period 1970q1 to 2009q2 they confirm Hansen's result that in the United States the extensive margin dominates business-cycle fluctuations in aggregate hours worked. As already stressed in the introduction, they find that the relative importance of the two margins in both countries is of similar magnitude. Noteworthy is especially that the relative magnitude of the intensive margin in Germany is surprisingly small when the whole period 1970 to 2009 is taken into account. They find that the relative contribution of the intensive margin to labour dynamics over the business cycle is less than 20 per cent in both countries. In Germany for the whole

period 1970q1 to 2009q2 it is in fact less than seven per cent (see also Table 1 which repeats their results to ease comparison). Furthermore, their results indicate that the magnitude of the intensive margin over time is more volatile in Germany than in the United States.

In Wesselbaum (2011) results of the relative importance of both margins for a group of nine countries, including Germany and the United States, over the period 1998q1 to 2010q1 are reported as part of an analysis of the relationship between the intensive margin and labour adjustment costs. While, for the United States an intensive margin of 21 per cent was reported which was only slightly higher than the results of Merkl and Wesselbaum (2011), the relative magnitude of the intensive margin in the case of Germany was equal to 34 per cent and therefore twice as large as the highest previously reported value and markedly higher than the values reported for the United States. Wesselbaum (2011) attributes this rise in the value of the intensive margin to the inclusion of data points covering the time period of the Great Recession and the use of policy measures like the short-time work program. But no further investigation or comments with respect to these differences are made in the analysis. The difference in data points between both studies is only three additional quarters at the end of the sample. According to the ECRI the trough of the business cycle was reached in the 2009q1, which was included in Merkl and Wesselbaum's (2011) sample. However, the data sample used by both studies might markedly differ due to data revision conducted later by the Federal Statistical Office in Germany.

Kakinaka and Miyamoto (2012) using the same method as Merkl and Wesselbaum (2011) investigate the relative importance of the two margins of labour adjustment over the business cycle in Japan for the sample period 1970q1 to 2012q2. They show that the intensive margin accounts for more than three quarters of the variation in total hours worked. Hence in contrast to the United States and Germany the dominant margin of labour adjustment over the business cycle in Japan is the intensive margin. Furthermore, their results show that similar to the United States and in contrast to Germany the relative importance of the intensive margin in Japan is remarkable stable over time.

Taskin (2013) provides a comparative analysis of the relative importance of the extensive and the intensive margin over the business cycle in Turkey and the United States for the period 1955 to 2012 using annual data. Similar to the finding of Merkl and Wesselbaum (2011) for Germany and the United States, Taskin (2013) finds that the relative importance of the two margins in Turkey and the United States is of similar magnitude.

Ohanian and Raffo (2012) built a new quarterly dataset of total hours worked which spans the time period 1960 to 2010 and covers 14 OECD countries, including Germany and

the United States. Different from the approach used in the studies presented above, they investigate the magnitude of standard deviations of HP-filter residuals of hours per worker respectively employment relative to those of output as well as labour and productivity wedges over time and for different OECD economies. They conclude that a large fraction of labour adjustment over the business cycle takes place via the intensive margin. They do report only results for the average of France, Germany, and Italy under the heading Euro, but no individual results for Germany. Van Rens (2012) in a discussion of Ohanian and Raffo (2012), published in the same issue of the journal, questions this result of Ohanian and Raffo (2012). He presents some peak-to-trough changes of log deviations for total hours worked and employment for Germany, the United States, Europe, France and Italy (Table 1 in van Rens 2012, p. 60). His results show that the relative importance of the extensive margin in the Unites States is remarkably stable over time and very much in line with the findings of the other studies presented above although the actual quantitative results are not directly comparable. In contrast in Germany the relative importance of the extensive margin varies markedly over time, and its magnitude differs between Germany and the United States.

3. DATASET

To ease comparison between the results of the analysis presented in this paper and the results of Merkl and Wesselbaum (2011) this study follows their exposition as closely as possible, especially with respect to the dataset used.

The analysis is based on quarterly time series data for employment, *N*, and hours per worker, *H*. They are seasonally adjusted using the multiplicative Census X12-Arima method. For the United States data from the Bureau of Labour Statistics for the period 1970q1 to 2014q1 are used.

For Germany, two samples are available from the Federal Statistical Office. The first West German sample covers the period from 1970q1 to 1991q4. From 1991q1 time series for unified Germany as a whole are available. The second German sample used in the analysis covers the period from 1991q1 to 2014q1. Despite the structural break in 1991, following the procedure of Merkl and Wesselbaum (2011), we synthetically combine West German and German data to obtain long time series covering the whole time period from 1970q1 to 2014q1. To eradicate the structural break in the data the initial jump in each time series is subtracted from each consecutive observation after 1990q4 (see Merkl and Wesselbaum, 2011, p.806).

However, we think this synthetical combination of West German data and data for Germany as a whole after reunification like any other procedure to cope with a structural break is problematic as it has a significant impact on the results of the analysis. This will

become apparent in the following sections. Therefore we prefer to use the two subsamples to obtain results from the separate analyses of West Germany until 1991 and unified Germany from 1991 onwards.

The natural logs of employment, *n*, and hours worked per worker, *h*, are used. With the help of the Hodrick-Prescott filter with smoothing parameters *1 600* respectively *100 000* the cyclical components of the time series employment, $\tilde{n}$, hours worked per worker, $\tilde{h}$, and total hours worked, $\tilde{t}$, are obtained, with

$$\tilde{t} = \tilde{n} + \tilde{h}. \tag{1}$$

For quarterly data, when using a Hodrick-Prescott filter, the standard practice is to choose a value of 1 600 for the smoothing parameter, λ. However, since Shimer (2005) introduced a smoothing parameter set to 100 000 in his business-cycle analysis of the US labour market, recently other business-cycle analyses have followed his practice (see e.g. Mortensen and Nagypál 2007 and Costain and Reiter 2008), although Shimer (2005) did not provide any justification for the use of the much larger smoothing parameter. Merkl and Wesselbaum use a smoothing parameter of 100 000, too, but report that for robustness reasons they also performed their analysis with the standard value 1 600. For the entire sample period with the combined German time series, their findings based on the much smoother trend are by and large confirmed. Hornstein et al. (2005) show that, with respect to the variables used in Shimer's (2005) analysis, the standard deviations of the investigated variables change while their relative volatilities stay almost the same when different smoothing parameters are used. However, this is not the case in our analysis with respect to the German variables. While the standard deviations of all three variables decrease, the relative volatility of hours worked per worker increases with respect to total hours worked as well as employment and the relative volatility of employment with respect to total hours decreases when the standard smoothing parameter of 1 600 is used instead of the larger value of 100 000 (Table A1 in the Appendix). With respect to the United States data the conclusion of Hornstein et al. (2005) is more or less confirmed (Table A2 in the Appendix). In the following we proceed with our analysis by presenting results for both the standard value of 1 600 as well as Shimer's smoothing parameter of 100 000 which enables comparisons with the results of Merkl and Wesselbaum (2011). The cyclical components for the United States and Germany obtained by the use of the Hodrick-Prescott filter with the two different smoothing parameters are presented in Figure 1 to Figure 3.

Figure 1: Aggregate Labour Adjustment in the United States 1970 to 2014

Figure 2: Aggregate Labour Adjustment in Germany 1970 to 2014

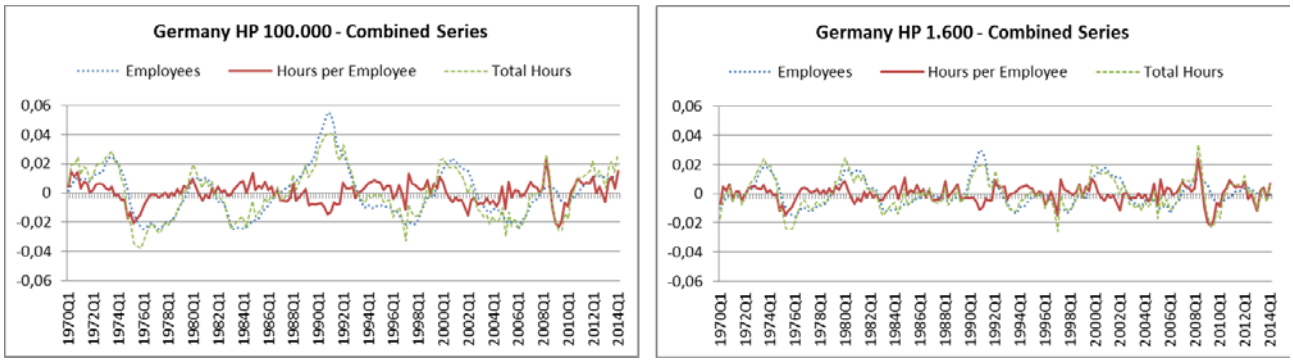
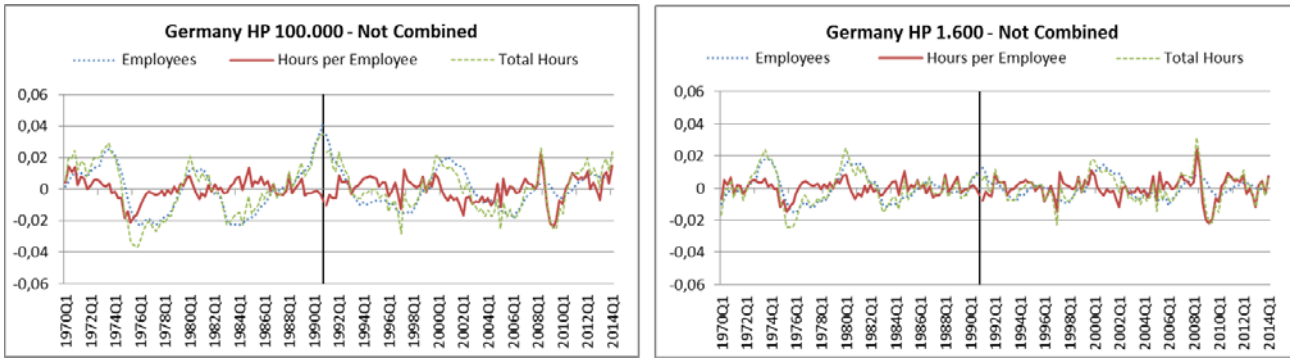


Figure 3: Aggregate Labour Adjustment in Germany

(Subsamples: 1970 to 1991 and 1991 to 2014)



4. EMPIRICAL ANALYSIS

How is it possible that in Germany temporary working-time flexibility helped safeguarding jobs during the Great Recession when the intensive margin in Germany can explain only roughly the same share of the total business-cycle volatility of total hours worked as the intensive margin in the United States? The analysis presented in this section provides an answer to this question.

Following Merkl and Wesselbaum (2011) the starting point of the empirical analysis are equations (2) and (3) and there especially the magnitudes of ϑ^{INT} and ϑ^{EXT}, the relative contributions of the intensive margin respectively the extensive margin to the total variation of total hours worked over the business cycle[2]:

$$\boldsymbol{var}(\tilde{t}) = var(\tilde{n}) + var(\tilde{h}) + 2cov(\tilde{n},\tilde{h}) = \boldsymbol{cov}(\tilde{t},\tilde{h}) + \boldsymbol{cov}(\tilde{t},\tilde{n}) \quad (2)$$

and

$$\mathbf{1} = \frac{cov(\tilde{t},\tilde{h})}{var(\tilde{t})} + \frac{cov(\tilde{t},\tilde{n})}{var(\tilde{t})} = \boldsymbol{\vartheta^{INT}} + \boldsymbol{\vartheta^{EXT}}. \quad (3)$$

For the ease and clarity of exposition the original results of Merkl and Wesselbaum (2011, Table 1) are repeated in Table 1. We present only the values of the intensive margin ϑ^{INT} since the values of the extensive margin can be inferred from the fact that $\vartheta^{EXT} = 1 - \vartheta^{INT}$. Furthermore, the scientific paradox stated above and hence the focus of our analysis is on the comparative relative importance of the intensive margin in Germany and the United States.

Table 1: Original Results of Merkl and Wesselbaum (2011)

	1970 to 2009	**1970 to 1990**	**1991 to 2009**
Germany	6.7	17.0	15.2
United States	14.6	12.4	17.5

A closer look at their results provides some noticeable findings: In Germany for the whole sample period 1970 to 2009 the proportion of the total variation in total hours worked that is due to the intensive margin is very small. It is only half the magnitude observed for the United States. Furthermore, somewhat puzzling its contribution is less than half the size observed in the two subsamples 1970 to 1990 respectively 1991 to 2009.

In a first step the analysis of Merkl and Wesselbaum (2011) is repeated based on our longer and more recent sample. In Table 2 for Germany and the United States the relative contribution of the intensive margin to the total variation of total hours worked over the business cycle are presented for five different sample periods, including the ones studied by Merkl and Wesselbaum (2011) as well as two additional subsamples 1970 to 2014 and 1991

[2] This measure was first used by Fujita and Ramey (2009) in an analysis of unemployment fluctuations. Hansen (1985) just uses the middle part of equation (2) and focuses on the ratio of the variance of employment ($\tilde{n}$) respectively the variance of hours per worker ($\tilde{h}$) and the variance of total hours ($\tilde{t}$), $\vartheta^{EXT} = \frac{var(\tilde{n})}{var(\tilde{t})}$ and $\vartheta^{INT} = \frac{var(\tilde{h})}{var(\tilde{t})}$, to quantify the importance of the extensive and intensive margin over the business cycle in the US.

to 2014. The results in the top half of Table 2 are based on a smoothing parameter $\lambda = 100\,000$ and $\lambda = 1\,600$ in the bottom half.

Table 2: Intensive Margin in Germany and the United States - New Results

Smoothing Parameter $\lambda = 100\,000$

	1970 to 2009	**1970 to 1990**	**1991 to 2009**	**1970 to 2014**	**1991 to 2014**
Germany	9.9	17.0	24.5	13.6	33.3
USA	13.8	11.1	16.5	13.7	15.6

Smoothing Parameter $\lambda = 1\,600$

	1970 to 2009	**1970 to 1990**	**1991 to 2009**	**1970 to 2014**	**1991 to 2014**
Germany	25,2	24,5	35,7	29,0	58,8
USA	15,2	14,1	17,0	15,3	16,8

Firstly, the results presented in Table 2 largely confirm Merkl and Wesslbaum's (2011) finding that in both countries the extensive margin is the dominant mechanism in the labour market adjustment process. The exemption is in the case of a smoothing parameter $\lambda = 1\,600$ the subsample 1991 to 2014 which includes the period of the Great Recession. Here the intensive margin is the dominant mechanism in the labour market adjustment process in Germany. The proportion of the intensive margin of the total variation in total hours worked is 59%.[3] With a larger smoothing parameter ($\lambda = 100\,000$) the contribution of the intensive margin since 1991 is notably smaller but still explains one third of the business-cycle variation in total hours worked.

Secondly, whereas the findings for the US are very robust with respect to different sample periods and varying smoothing parameters, there is a lot of variation in the results for Germany. In the case of the US the quantitative importance of the intensive margin with respect to the labour market adjustment process is between 11% and 17%; for Germany the range of results is between 10% and 60%.

Furthermore, the finding of Merkl and Wesselbaum (2011) that the quantitative importance of the extensive margin and hence of the intensive margin is of similar magnitude in Germany and the US is only confirmed in the case of a very smooth trend component due to the large smoothing parameter $\lambda = 100\,000$ and the use of synthetically combined time

[3] A word of caution is necessary with respect to the exact value of ϑ^{INT} in the subsample 1991 to 2014 since the HP-Filter has a well-known endpoint problem, i.e. the impact of observations at the end of the time series on the trend component at the end of the sample is too large (see e.g. St-Amant and van Norden 1996, Baxter and King 1995).

series for Germany and with some limitations in the case of West Germany before unification when the proportion of the intensive margin is 17% and therefore only 5 percentage points larger than in the US. For Germany after unification and in the case of the more common smoothing parameter $\lambda = 1\,600$ the importance of the intensive margin is (much) greater in Germany and seems to have increased in recent years. Especially, in the time period 1991 to 2014 a proportion between one third and nearly 60% of total variation in total hours worked is due to the intensive margin in Germany, in contrast to a proportion of roughly one sixth in the US.

With regard to the aim of our inquiry most importantly, there is no longer a paradox with respect to the importance of the intensive margin for the German employment success in the Great Recession. Because our findings indicate that the importance of the intensive margin in Germany increases significantly when more recent data and especially more revised data information with respect to the time period of the Great Recession and after are included in the analysis. Furthermore, our findings also indicate that the use of synthetically combined time series to overcome the problem of German unification as well as the very large smoothing parameter $\lambda = 100\,000$ instead of the standard parameter of $\lambda = 1\,600$ might have played a role for the surprising finding by Merkl and Wesselbaum (2011) that the importance of the intensive margin is of similar magnitude in Germany and the US.

To improve our understanding of the differences between the results presented here and Merkl and Wesselbaum's (2011) finding, as a second step, the above analysis is repeated for recent business-cycle periods in the US and Germany. Then, rolling calculations of the proportion of the intensive margin of total variation based on a nine year window are presented.

Next, for both countries we investigate different business-cycle periods since 1990. This time period is chosen to make sure the focus is on Germany after reunification. Firstly, to avoid possible data problems, and, secondly, the above results showed that especially from 1991 to 2014 there are notable differences between the German and the US economy with respect to the relative importance of the intensive margin.

The dating of the business cycle for Germany is from the Economic Cycle Research Institute (ECRI) which uses a similar approach as the NBER's Business Cycle Dating Committee responsible for determining the official U.S. business-cycle dates, to determine business-cycle dates for 20 other countries including Germany. For the US the official business-cycle dates from NBER's Business Cycle Dating Committee are used. For both countries there are two complete cycles, defined from trough to next trough, and one yet uncompleted cycle from 1990 to 2014. The exact cycle dates for the US are from the 1991q1

to 2001q4 (US Cycle 1) and from 2001q4 to 2009q2 (US Cycle 2) as well as the most recent cycle beginning with the trough in 2009q2 (US Cycle 3). The corresponding business-cycle dates for Germany are form 1994q2 to 2003q3 (GER Cycle 1) and from 2003q3 to 2009q1 (GER Cycle 2) as well as the most recent cycle beginning with the trough in 2009q1 (GER Cycle 3). The proportion of the intensive margin of total variation in total hours worked for these various cycles is shown in Table 3.

Table 3: The Importance of the Intensive Margin in Different Business Cycles for the US and Germany

A) The Intensive Margin in Different Business Cycles for the United States

	HP 100 000	**HP 1 600**
1991q1 to 2001q4	15.7	17.0
2001q4 to 2009q2	17.8	17.3

B) The Intensive Margin in Different Business Cycles for Germany

	HP 100 000	**HP 1 600**
1994q2 to 2003q3	13.2	35.8
2003q3 to 2009q1	60.6	65.3

C) The Intensive Margin in the Most Recent Business Cycles Since 2009

2009 to 2014q1	**HP 100 000**	**HP 1 600**
Germany	72.0	92.4
USA	23.8	19.9

The results in Table 3 confirm again that in the United States the proportion of the intensive margin of total variation in total hours worked is remarkably stable when only the completed cycles are looked at, independent of the chosen smoothing parameter and the cycle period. The impact of the intensive margin in the US Cycle 3 is higher. However, the number of observations in Cycle 3 is still quite small and therefore not too much emphasis should be put on this finding. Except of US Cycle 1 and a smoothing parameter $\lambda = 100\,000$ the magnitude of the intensive margin is slightly higher than the numbers presented above for the longer sample periods. Yet the differences are relatively small, and hence the results are therefore quite in line with the above findings.

With respect to the German labour market the exact magnitude of the intensive margin depends again crucially on the choice of the smoothing parameter. The proportion of the intensive margin of total variation of hours worked is higher when the standard smoothing parameter $\lambda = 1\,600$ is used than when $\lambda = 100\,000$ is chosen. Furthermore and most remarkably, in accordance with the literature on Germany's employment miracle during the Great Recession independent of the choice of the smoothing parameter in GER Cycle 2 the intensive margin is more important than the extensive margin. In this business cycle which includes the Great Recession the proportion of the intensive margin of total variation in total hours worked is larger than 60%. It is much higher than in the US and also much higher than in the previous cycle.

Finally, in Germany the importance of the intensive margin is notably higher in the most recent (unfinished) business cycle than in the previous business cycle. This is quite remarkable given the already high contribution of the intensive margin observed in the previous business cycle. However, some caution seems appropriate with respect to possible interpretations of this finding. One reason for the high value of ϑ^{INT} is a direct consequence of the Great Recession. As a consequence of the temporary nature of the working-time reductions in Germany in the Great Recession the remarkable reduction in the average hours worked per worker during the slump requires an increase of an approximately similar magnitude in the ensuing economic recovery after the Great Recession. Furthermore, an interesting but at the moment unanswerable question in this context is whether this dramatic change in the importance of the intensive margin of labour adjustment in Germany is only temporary or permanent. It could be possible that due to the available range in instruments to flexibly adjust individual hours worked and the demographic changes taking place in the German economy firms have become less dependent on respectively more reluctant to use the extensive margin for adjustments over the business cycle. However, it is also possible that as time continues and this business cycle matures the importance of the intensive margin will decline.

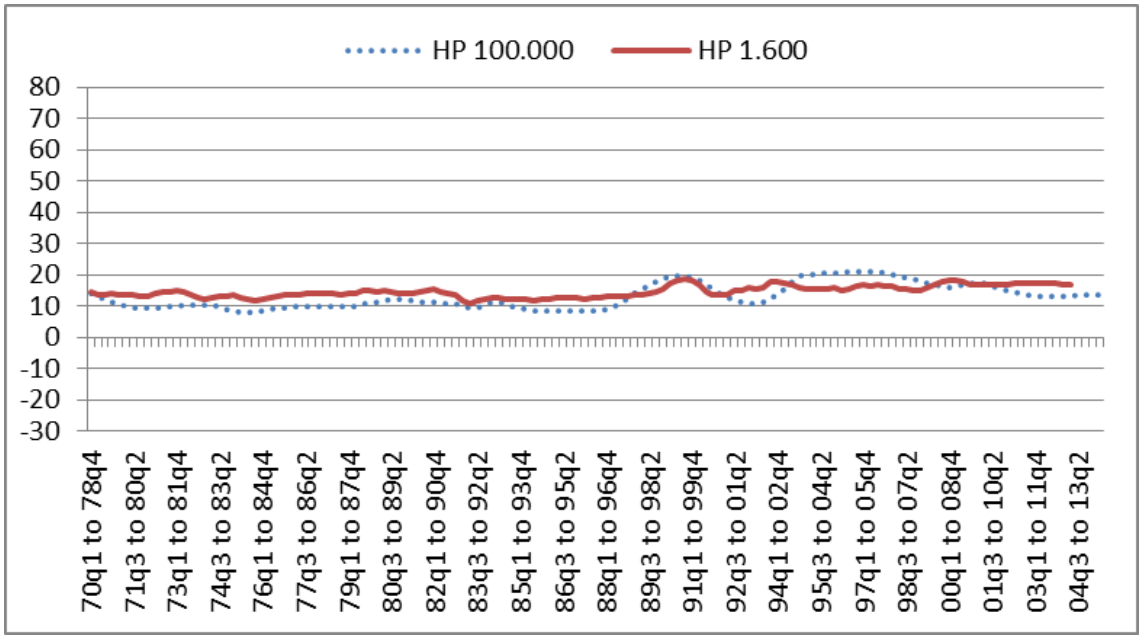
One potential problem of the above approach is due to the fact that the length of the business cycles varies over time and between countries which might influence the presented results. Additionally, in contrast to the United States, there is no “official” business-cycle dating in Germany and of course the above results might be sensitive to the exact determination of the troughs and hence the business cycles. Therefore to further improve our understanding of the relative importance of the intensive margin for the total variation in total hours worked, the final part of our empirical analysis calculates the proportion of the intensive margin ϑ^{INT} for a rolling window of 36 quarters (nine years) for Germany as well as the United States using again the two different smoothing parameters.

In comparison to the analysis of different business cycles, this method has two obvious advantages: While the length of a complete business cycle from trough to trough may vary over time and country, the length of the intervals is fixed. Furthermore, the use of rolling windows helps to identify specific time periods of extreme changes in the relative importance of the intensive margin. In Figure 4 the results of ϑ^{INT} for the whole sample from 1970q1 to 1914q1 are presented.

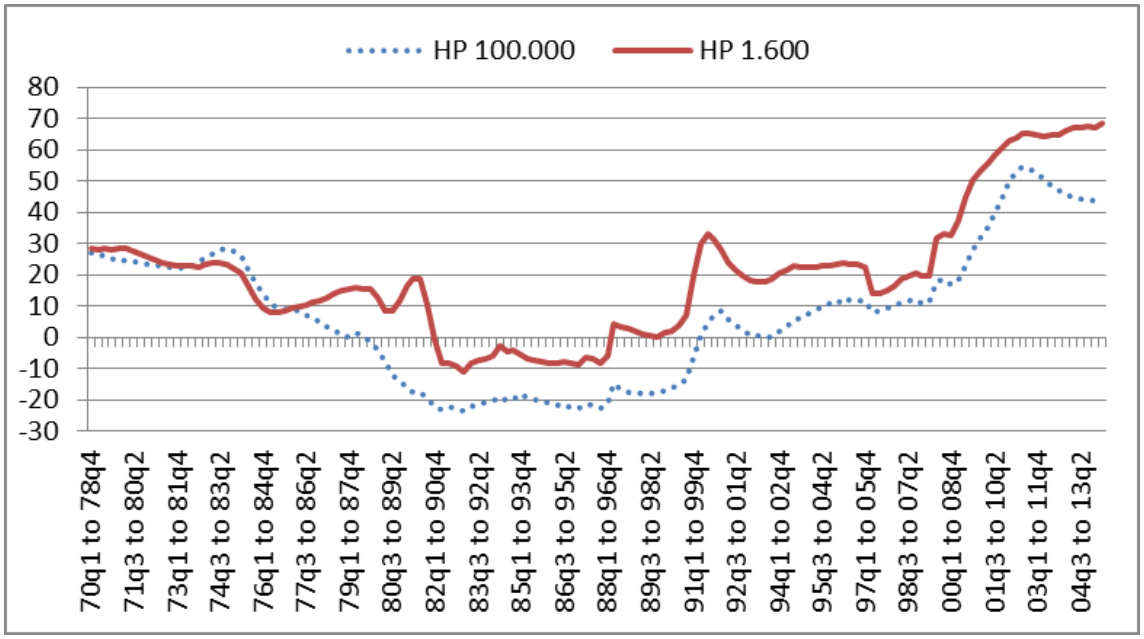
Figure 4: Intensive Margin in the United States and Germany

(Rolling windows of 36 quarters, 1970 to 2014)

A) United States



B) Germany



Firstly, a closer inspection of the rolling intervals from 1970 to 2014 confirms again, as expected, that the relative importance of the intensive margin in the United States is remarkable stable over time.

Secondly, in the case of the Germany economy ϑ^{INT} is much more volatile and a kind of slightly u-shaped pattern emerges. Rolling intervals which include observations from

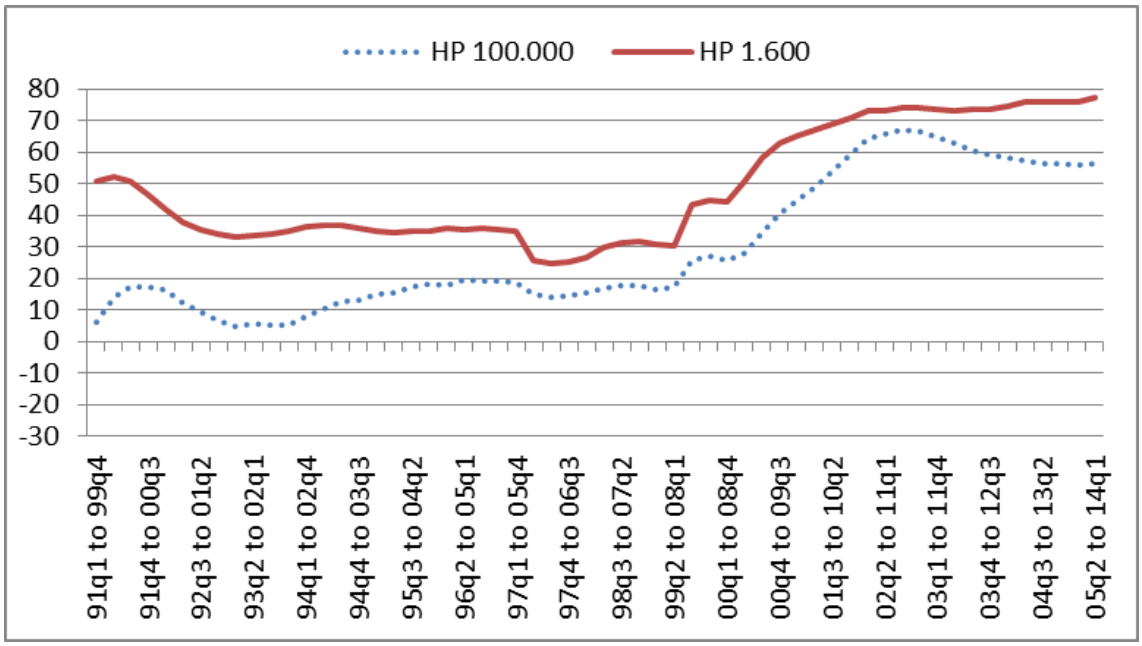
1988q3 to 1991q3, the time period around the German unification and around the synthetical combination of the time series for West Germany and Germany, the magnitude of the relative importance of the intensive margin decreases strongly and its sign becomes negative, i.e. there is a negative covariance between hours per worker and total hours worked. This pattern is especially pronounced when a very smooth trend component as in the analysis of Merkl and Wesselbaum (2011) is chosen.

Thirdly, these periods of a negative covariance between hours per worker and total hours worked are also the reason for the very low overall level of ϑ^{INT} in the case of the combined time series and the fact that the magnitude of ϑ^{INT} is larger in the two subsamples, where the combined series are not used, than in the overall sample. In around 30% of the investigated rolling intervals the covariance between total hours worked and hour worked per worker is negative and therefore the sign of ϑ^{INT} is negative, too. One possible explanation could be the policy of collectively agreed working-time reductions in the mid-1980s irrespective of the total hours worked over the business cycle. The findings can also be interpreted as casting doubts on the usefulness of artificially combining West German time series and German time series after reunification and therefore in the approach to ignore the obvious structural break due to the German reunification.

Overall, it seems more plausible to accept that with the German unification wide ranging structural changes happened in the German labour market, some of them were surely only temporary in nature but others were permanent. Therefore next for Germany the analysis with the rolling intervals is repeated focusing on the time period after unification from 1991q1 to 2014q1 (Figure 5).

Figure 5: Intensive Margin in Germany

(Rolling windows of 36 quarters; 1991 to 2014)



Firstly, the magnitude of ϑ^{INT} is larger than in the case of the combined series. In general, again, the rolling intervals for the subsample 1991q1 to 2014q1 confirm the pattern that the higher the smoothing parameter the smaller the relative importance of the intensive margin. The development of the magnitude of ϑ^{INT} over time is similar to the analysis presented in Figure 4.

Moreover, the relative importance of the intensive margin, ϑ^{INT}, is larger in the early rolling intervals including observations immediately after German unification. Then, a large rise in the magnitude of ϑ^{INT} occurs when observations of the time of the Great Recession are included in the rolling intervals. Both of these changes in the scale of ϑ^{INT} are in line with expectations and can be explained by using information on the policies performed in Germany during these time periods. During the period of German reunification and in its aftermath the government tried to counteract respectively tried to soften the impact of the structural shock on the East German labour market by using the short-time work program on a very large scale (Bogedan 2010, p. 581). During the Great Recession a lot of studies show that several measures of internal flexibility like short-time work, working-time accounts or the reduction of overtime work were used to adjust the use of labour input. However, some caution seems appropriate with respect to these possible interpretations due to the so-called end-point problem of two-sided filters like the Hodrick-Prescott-Filter. All two-sided filters suffer from the problem that observations at the beginning and the end of the sample weigh

more heavily in the determination of the trend respectively the cyclical component. Therefore, the higher values of ϑ^{INT} could be slightly exaggerated due to the end-point problem.

Finally, the actual magnitude of ϑ^{INT} in the rolling windows which include information from the Great Recession is remarkable. The great importance of the intensive margin in this time period is confirmed and the actual results are in line with the findings in the analyses presented above. Furthermore, with a smoothing parameter $\lambda = 1\,600$ the magnitude of ϑ^{INT} during these latter rolling windows is more in line with the values observed in the early 1990s after German unification as if the larger smoothing parameter $\lambda = 100\,000$ is used.

5. CONCLUSION

In general, as expected, our results confirm the dominance of the extensive margin of labour adjustment in Germany and the United States. The study presented here shows that when the relative importance of both margins of labour adjustment in Germany is analyzed, the use of synthetically combined time series covering the periods before and after reunification is problematic! The similar magnitude of the relative importance of the two margins in Germany and the United States found by Merkl and Wesselbaum (2011) holds only for a smoothing parameter of 100 000 and for the whole sample period of 1970 to 2014 (when the synthetically combined time series for Germany are used). This does apply for the common smoothing parameter of 1 600.

Furthermore, in contrast to the United States, the relative importance of the intensive margin varies over time in Germany. The relevance of the intensive margin dramatically increased in recent years in Germany and the intensive margin accounts for nearly 60 to 80% of the change in total hours worked.

Our results are in line with the findings of studies investigating the German labour market performance during the Great Recession which showed that internal flexibility based on various instruments like working-time accounts, short-time work and collectively agreed temporary reductions in standard working hours played a crucial role in stabilizing employment during the Great Recession. Furthermore, the results of our study solve a supposed contradiction. Merkl and Wesselbaum's result of a similar relative importance of the intensive margin in Germany and the United States depends crucially on the use of a smoothing parameter for the Hodrick-Prescott Filter of 100 000 and on the synthetical combination of West German data and German data after reunification. More generally, the relative importance of the intensive margin is larger in Germany than in the United States. In addition, in the last decade the relative importance of the intensive margin in Germany

increased markedly. In the Great Recession and in the subsequent period the intensive margin was the dominant margin of labour adjustment

Based on our empirical findings we can qualify some of the implications derived by Merkl and Wesselbaum (2011) and add some additional implications:

We agree with Merkl and Wesselbaum's (2011) statement that business-cycle researchers should not omit the extensive margin in their business cycle framework, as it is in general the dominant adjustment mechanism in aggregate total hours worked over the business cycle in Germany and in the United States, especially when the focus is on very long time periods.

However, based on our findings on the relative importance of the intensive margin of labour adjustment, in contrast to Merkl and Wesselbaum (2011), we do not think that it may be a plausible short-cut to exclusively use the extensive margin in theoretical business-cycle models when the aspirations of the models are to derive general results which do not only apply to the US economy but also to other economies like the German one, or to provide general explanations of developments during important events in economic history like the Great Recession.

Based on our findings that there are marked differences with respect to the magnitude of the relative importance of the intensive margin in Germany and the United States and that the size of the intensive margin in Germany is quite volatility over time we conclude that the labour markets in these two countries are quite different and might require different modelling approaches to ensure that important characteristics of European economies are not ignored.

Our results with respect to the intensive margin in Germany suggest that much further theoretical as well as empirical research is needed to improve our understanding of the magnitude as well as the stability respectively the volatility over time of the relative importance of both margins of labour adjustment and the interaction between them.

APPENDIX

Table A1: Germany

	λ = 1 600			λ = 100 000		
1970 to 2014	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$
Standard Deviation	0.011	0.009	0.006	0.018	0.017	0.008
Autocorrelation	0.778	0.941	0.460	0.906	0.975	0.642
Correlation Matrix						
$\tilde{t}$	1.000	0.832	0.522	1.000	0.906	0.318
$\tilde{n}$	0.832	1.000	-0.039	0.906	1.000	-0.114
$\tilde{h}$	0.522	-0.039	1.000	0.318	-0.114	1.000

	λ = 1 600			λ = 100 000		
1970 to 1990	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$
Standard Deviation	0.011	0.009	0.005	0.018	0.016	0.007
Autocorrelation	0.817	0.929	0.439	0.913	0.932	0.721
Correlation Matrix						
$\tilde{t}$	1.000	0.901	0.560	1.000	0.930	0.460
$\tilde{n}$	0.901	1.000	0.146	0.930	1.000	0.102
$\tilde{h}$	0.560	0.146	1.000	0.460	0.102	1.000

	λ = 1 600			λ = 100 000		
1991 to 2014	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$
Standard Deviation	0.009	0.006	0.007	0.013	0.011	0.008
Autocorrelation	0.633	0.903	0.436	0.786	0.915	0.559
Correlation Matrix						
$\tilde{t}$	1.000	0.638	0.764	1.000	0.791	0.542
$\tilde{n}$	0.638	1.000	-0.009	0.791	1.000	-0.086
$\tilde{h}$	0.764	-0.009	1.000	0.542	-0.086	1.000

Table A2: United States

	λ = 1 600			λ = 100 000		
1970 to 2014	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$
Standard Deviation	0.020	0.018	0.004	0.029	0.025	0.006
Autocorrelation	0.919	0.936	0.757	0.950	0.960	0.861
Correlation Matrix						
$\tilde{t}$	1.000	0.986	0.723	1.000	0.985	0.670
$\tilde{n}$	0.986	1.000	0.596	0.985	1.000	0.531
$\tilde{h}$	0.723	0.596	1.000	0.670	0.531	1.000

	λ = 1 600			λ = 100 000		
1970 to 1990	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$
Standard Deviation	0.022	0.020	0.005	0.027	0.025	0.005
Autocorrelation	0.896	0.921	0.666	0.920	0.941	0.750
Correlation Matrix						
$\tilde{t}$	1.000	0.987	0.706	1.000	0.984	0.567
$\tilde{n}$	0.987	1.000	0.582	0.984	1.000	0.411
$\tilde{h}$	0.706	0.582	1.000	0.567	0.411	1.000

	λ = 1 600			λ = 100 000		
1991 to 2014	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$	$\tilde{t}$	$\tilde{n}$	$\tilde{h}$
Standard Deviation	0.019	0.016	0.004	0.031	0.026	0.006
Autocorrelation	0.949	0.956	0.834	0.970	0.975	0.908
Correlation Matrix						
$\tilde{t}$	1.000	0.984	0.745	1.000	0.986	0.743
$\tilde{n}$	0.984	1.000	0.614	0.986	1.000	0.623
$\tilde{h}$	0.745	0.614	1.000	0.743	0.623	1.000

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