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EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 26/2013

Potential labour force in full-time equivalents: measurement, projection and applications

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Internet http://www.bundesbank.de

ISBN 978–3–86558–935–4 (Printversion)
ISBN 978–3–86558–936–1 (Internetversion)

Non-technical summary

The labour supply in an economy is frequently measured in terms of the potential labour force. It encompasses all members of the domestic resident population who are actually working or willing to work. For some applications, it is appropriate to measure the potential labour force in the form of headcount. However, headcount falls short when it comes to gauging the productive capacity of the potential labour supply measured in terms of the number of hours worked by the people who are able to participate in working life. The potential labour force in full-time equivalents is a concept that accounts for the working time component.

The study focuses on assessing potential labour force in full-time equivalents over the short to medium run, with particular attention being paid to two aspects compared with the long-run projections prevalent in the literature. Firstly, it takes a holistic view of labour force participation and working time, as these are often mutually determining factors in individual labour supply decisions. Secondly, it considers the influence of migration on the supply side of the labour market. The proposed calculation method for determining the potential labour force is designed to depict migration scenarios in a flexible way. This is necessary, as the coordinated population projections of Germany's federal and regional statistical offices are only produced at intervals of several years. Hence, they can soon become out of date with a view to the short and medium-run migration assumptions which, moreover, are rather technical than based on economic reasoning. Apart from the basis projection, the paper presents the results of alternative scenarios.

The basis of the calculation is the resident working-age population which is divided into sub-categories in a manner that reflects age- and gender-specific differences in labour force participation and working-time preferences. Furthermore, in this calculation method, a distinction is made depending on whether the people are living permanently in Germany or are migrants who immigrated a short time ago and wish to remain in Germany only on a temporary basis.

According to the projections, the (headcount) potential labour force can be stabilised until at least 2020 due to rising age and population category-specific participation rates and the assumed migration surplus. In full-time equivalents, however, a decline of almost 1% compared with 2012 is expected. This reflects the ageing of the population, which is likely to significantly affect aggregate labour supply by cohort effects. The underlying assumption is that older persons stay longer in working life – but only to reduced working hours.

Finally, the paper presents two applications of the potential labour force in full-time equivalents. The first application illustrates the ageing effect on the supply of labour. The second example figures out the conditions which have to be fulfilled using the potential labour force in full-time equivalents as a metric for trend hours worked. A central condition is that standard working hours of full-time workers are constant over time. This can be regarded as being met in the projection horizon.

Nicht-technische Zusammenfassung

Das Arbeitsangebot in einer Volkswirtschaft wird häufig durch das Erwerbspersonenpotenzial gemessen. Es umfasst alle Personen der inländischen Wohnbevölkerung, die sich am Erwerbsleben tatsächlich beteiligen oder beteiligen wollen. Für manche Fragestellungen ist die Messung des Erwerbspersonenpotenzials in Form einer „Zahl an Köpfen“ angemessen. Wenn es um die Abschätzung der Produktionsleistung des potenziellen Arbeitsangebots geht, ist aber der von den Personen, die sich am Erwerbsleben beteiligen können, potenziell zu erbringende Stundenumfang relevant. Das Erwerbspersonenpotenzial zu Vollzeitäquivalenten ist ein Konzept, das den Einfluss der Arbeitszeitkomponente berücksichtigt.

Die Studie konzentriert sich auf die Abschätzung des Erwerbspersonenpotenzials zu Vollzeitäquivalenten in kurz- und mittelfristiger Perspektive. Hierbei wird im Vergleich zu den vorherrschenden Langfristprojektionen zwei Aspekten besondere Aufmerksamkeit geschenkt. Zum einen handelt es sich um eine integrierte Betrachtung von Erwerbsbeteiligung und Arbeitzeit, da sie sich im Rahmen individueller Arbeitsangebotsentscheidungen häufig gegenseitig bedingen. Zum anderen wird der Einfluss der Migration auf die Angebotsseite des Arbeitsmarkts thematisiert. Es ist sinnvoll, mit flexiblen Annahmen rechnen zu können, weil u.a. die koordinierten Bevölkerungsberechnungen des Statistischen Bundesamts und der Statistischen Landesämter nur in mehrjährigen Abständen erstellt werden und daher mit Blick auf die kurz- und mittelfristigen Migrationsannahmen, die überdies technisch abgeleitet und nicht ökonomisch begründet sind, schnell veralten können. Das Papier stellt deshalb neben einer Basisprojektion auch alternative Szenarien vor.

Ausgangspunkt der Rechnungen ist die Wohnbevölkerung im erwerbsfähigen Alter. Sie wird so in Teilgruppen untergliedert, dass alters- und geschlechtsspezifische Unterschiede in der Erwerbsbeteiligung und der Neigung, in Teilzeit zu arbeiten, abgebildet werden können. Darüber hinaus wird in diesem Rechenansatz auch danach unterschieden, ob es sich um auf Dauer im Inland lebende Personen oder um Migranten handelt, die erst vor kürzerer Zeit zugewandert sind und sich möglicherweise auch nur vorübergehend in Deutschland aufhalten wollen.

Den vorgestellten Projektionen zufolge lässt sich das Erwerbspersonenpotenzial durch Steigerung der alters- und personenspezifischen Partizipationsraten sowie den zu erwartenden Wanderungsüberschuss bis 2020 stabilisieren. In Vollzeitäquivalenten gerechnet, muss aber mit einem Minus von fast 1 % gegenüber dem Jahr 2012 gerechnet werden. Hierin drückt sich die Alterung der Bevölkerung aus, die über Kohorteneffekte erhebliche Auswirkungen auf das gesamtwirtschaftliche Arbeitsangebot haben dürfte. Hintergrund ist die Annahme, dass sich ältere Personen zwar immer länger am Erwerbsleben beteiligen, dies aber häufig nur zu verringerten Arbeitszeiten.

Abschließend werden zwei Anwendungen des Erwerbspersonenpotenzials zu Vollzeitäquivalenten vorgestellt. Das erste Beispiel illustriert den Altersstruktureffekt auf das Arbeitsangebot. Das zweite Beispiel legt dar, unter welchen Voraussetzungen das Erwerbspersonenpotenzial zu Vollzeitäquivalenten als Maß für das Trendarbeitsvolumen herangezogen werden kann. Eine zentrale Bedingung ist hier, dass die Regelarbeitszeit der Vollzeitbeschäftigten über die Zeit konstant ist. Dies kann für den Projektionshorizont als erfüllt angesehen werden.

Bundesbank Discussion Paper No 26/2013

Potential labour force in full-time equivalents: measurement, projection and applications*

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Abstract

We propose a concept of potential labour force in full-time equivalents which can be used to measure aggregate labour supply in terms of hours worked. It is designed to calculate labour input in production function estimates of medium-run potential output. Particular attention is paid to the influence of immigration and the interdependency between labour force participation and working-time decisions. Assuming that participation in working life among older people and women will increase, and if migration surpluses remain high, the potential labour force is likely to be stabilised until 2020 despite the evident curbing impact of the age cohort effect. However, a decline is to be expected in full-time equivalents due to the negative repercussions of rising labour force participation on working hours.

Keywords: potential labour force, labour supply, immigration, ageing.

JEL classification: E31, G21.

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1 Introduction

The labour supply in an economy is frequently measured in terms of the potential labour force. Generally speaking, it encompasses all members of the domestic resident population who are actually working or willing to work or, under certain circumstances, are seeking to participate in working life. This metric is relevant for labour market analysis because, when compared with employment, it allows us to reach conclusions about existing slack or shortages and, based on that, make statements on issues such as the extent of wage pressure. Furthermore, potential labour force projections are important when investigating the long-run sustainability of government budgets and the social insurance systems. What these fields of application have in common is that it is appropriate or sufficient to measure the potential labour force in the form of headcount.

However, headcount falls short when it comes to gauging the productive capacity of the potential labour supply. In a macroeconomic production function, labour as a factor of production is normally measured as the number of hours worked during the period under review. Therefore it is not just the number of people who are able to participate in working life that is relevant, but also the number of hours they could potentially work. The concept of potential labour force in full-time equivalents that is introduced and discussed in this article combines both components in an aggregate variable.[1]

There are a number of empirically relevant interactions between potential labour force and part-time working. Fig. 1 illustrates how an increase in labour force participation at the aggregate level has gone hand in hand with a rising percentage of part-time employment. This pattern could continue in future if one considers that the domestic reserves for the labour market are chiefly to be found among the older segment of the population and among people who also have family commitments and are likely to have less time to devote to a career than the other population groups. The population will age at a much faster rate over the coming years and, because of cohort effects, this will have a substantial impact on the aggregate labour supply (Fuchs, 2009). This calls for a holistic view of labour force participation and working hours according to age groups. In the baseline scenario for the projections illustrated, for instance, based on plausible assumptions potential labour force will increase until 2016 and, despite a decline afterwards, will exceed the 2012 level even in 2020. In full-time equivalents, however, until 2020 we must expect an decline of almost 1% compared with 2012.

Trend estimates of hours worked are required for various calculations, including potential output in the short and medium run (i.e. up to a maximum of ten years from now). However, up to a scaling factor, potential labour force in full-time equivalents is only the same as trend hours worked if the standard working time of full-time workers do not change over time.[2] At the start of the 1990s, this condition was not met, because of

[1] The concept of potential labour force in full-time equivalents was introduced in Bbk (2012). This paper looks in greater depth at the conceptual foundations, describes at length the calculation method, including the assumptions upon which it is based, and presents further applications.

[2] Asef et al. (2011) mention this aspect in their discussion of the similarly related concepts of "hours worked" and "employment in full-time equivalents".

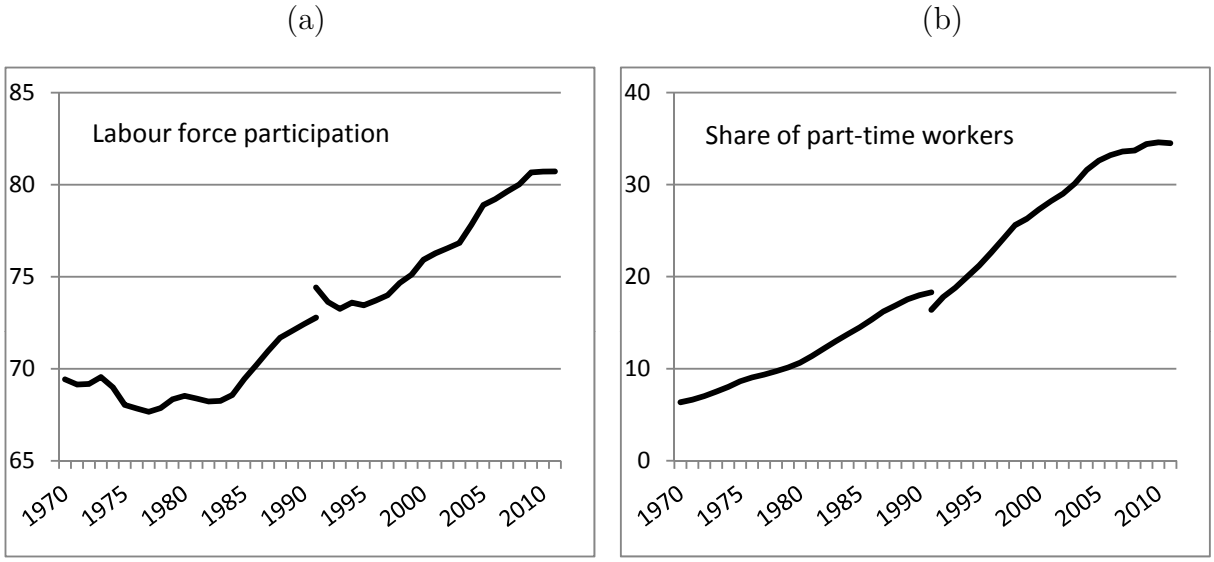

Figure 1: Labour force participation (as % of working-age population) and part-time share (as % of total employment). Figures for West Germany from 1970 to 1991 and for Germany as a whole from 1991 to 2011

the continuing impact of collective labour agreements providing for a general reduction in working hours. In the last decade, however, the standard working time of full-time workers remained almost constant. Conversely, however, based on the highly probable assumption that very few changes will occur in this respect by 2020, trend hours worked can be accurately approximated as a measure of labour input in aggregate production functions by the potential labour force in full-time equivalents.

An evaluation of migration effects on the potential labour force is another focus of the study. Migration is less predictable than natural population movements or changes in labour force participation. Over the projection horizon of up to ten years, the extent of immigration and emigration can be explained with sufficient plausibility by economic processes and, if appropriate, modelled through various scenarios. Substantial push and pull effects, for instance, could be engendered by the labour market differences within the European Union at present. These effects can be gauged not least from Germany's migration balance of the last few years. We also need to be flexible in the assumptions we make in this regard. By contrast, the coordinated population projections of Germany's federal and regional statistical offices are only produced at intervals of several years, so can soon become out of date with a view to the short and medium-run migration assumptions which, moreover, are rather technical than based on economic reasoning. The latest, 12th coordinated population projection, which was published in autumn 2009 (StaBu, 2009), is based on data up to 2008.[3]

[3]In the key variants of StaBu (2009) it is assumed that the migration surplus in the long run will be either 100,000 or 200,000 people per annum. Based on the migration balance for the most recent year for

The socio-demographic characteristics of the immigrants influence the potential labour supply. On the one hand, migration is distinguished by whether it is primarily labour market induced or motivated by other reasons. In this context, the gender distribution and age structure of immigrants must also be considered. On the other hand, it is assumed that the labour market-relevant characteristics of people who have moved to the country gradually converge with those of the permanent resident population over the course of their stay. For the calculation tool proposed here, this means that affiliation to a group that is assumed to have a specific labour force participation profile is determined not by nationality but by how long the person has been living in the host country. In contrast to this, the labour force participation estimate by the *Institut für Arbeitsmarkt- und Berufsforschung* (IAB) divides the resident population into West German, East German and Non-German; the transition from the third group to the first two is a corollary of naturalisation (Fuchs and Dörfler, 2005; Fuchs and Söhnlein, 2005).

The potential labour force in full-time equivalents is a concept which measures hours worked from the supply side. In their projections of this entity, Ehing and Moog (2012) take account not only of the working time of the employed persons but also of possible changes in unemployment rate trends. These also reflect structural factors which, from an analytical perspective, must be attributed either to labour demand or at least to labour market matching. Börsch-Supan and Wilke (2009) also refer to this factor when discussing working population projections which rely on assumptions about the long-run trend in the (cyclically adjusted) unemployment rate. In addition to the long-run projections for the potential labour force, Wanger et al. (2013) also present estimates (building on those projections) of trend hours worked in different working time scenarios.

This paper is structured as follows. Section 2 explains the conceptual and calculation bases for determining the potential labour force in full-time equivalents as an extension of the headcount potential labour force. We show how, in addition to macroeconomic data from the national accounts and the IAB calculation of hours worked, aggregate information from individual datasets such as the *Mikrozensus* and the German Socio-Economic Panel (SOEP) are used. Section 3 discusses two examples of how the potential labour force in full-time equivalents can be applied: estimating the ageing effect and trend hours worked. The study concludes with a summary.

2 Conceptual foundations and calculation method for the potential labour force in full-time equivalents

Potential labour force in full-time equivalents is a measure of the aggregate labour supply based on hours worked, as it incorporates the residents' decisions on labour force participation and working time in a single metric. It abstracts from cyclical and seasonal fluctuations

which statistics are available, the respective target figures are achieved after a five or ten-year monotonic adjustment process. Between 2009 and 2012, approximately 760,000 people moved to Germany on balance, whereas the projection for this four-year period predicted just a small total surplus of 80,000 people.

and other temporary influences (e.g. strikes). Terminology-wise, it still refers to potential labour force as the common headcount concept for the supply side on the labour market. How this is converted to full-time equivalents depends on the standard working hours of full-time workers. This implies that the trend in the total number of working hours that residents would provide in a given period only overlaps with the trend in the potential labour force in full-time equivalents if the standard working hours of full-time workers do not change.[4]

There are two ways of calculating the headcount potential labour force. Firstly, it comprises the resident working-age population, insofar as that population participates in working life. All people aged at least 15 years and who have not reached statutory retirement age are deemed to be of working age.[5] In this origin-based calculation, a distinction is also made by age and gender. Secondly, the potential labour force also encompasses the employed and active jobseekers as well as members of the working-age population who currently are neither employed nor unemployed but would be willing and, in cyclical normal capacity utilisation conditions, able to take up a job immediately.[6] This method, which is described here as a distribution-side calculation, is used to determine the working time components because the desired weekly working hours differ not only by age and gender, but also according to whether the people concerned are employed or unemployed or do not participate in working life.

The definition of people who, whilst not working, are included in the potential labour force is geared very much towards the criterion of immediate availability. The key factor here is that, ultimately, we are gauging the labour supply that could have an impact on production during the period under review. The definition is narrower than that of the hidden labour reserve. According to the IAB's concept, for instance, this also comprises "pensioners, people who are unable to work, placement students, school pupils and students" whose "only reason for not working is that the labour market does not offer any – or any adequate – employment opportunities." (Fuchs and Weber, 2010, p. 11) The majority of these people probably would not be willing or able to start or resume work immediately. The definition of the hidden labour reserve used by the *Statistisches Bundesamt* is also broader, based on the labour force concept of the International Labour Organization (ILO) (Rengers, 2012). Of the two sub-categories "seeking work but not available in the short term" and "available, but not seeking work" the latter is explicitly included in the concept discussed here, but not the former.

[4]This interrelationship is explained in more detail in section 3.2.

[5]Until the end of 2011 the statutory retirement age was 65 years. From 2012 onwards, it will rise by one month each year. Consequently, in 2029, people will reach "retirement at age 67". Because of this effect, the working-age population is around $\frac{3}{4}$ million higher than if the upper age limit were to remain constant at 65 years.

[6]The criterion of normal capacity utilisation has been chosen in order that we can use the measurement concept introduced here as a metric for labour input in production function estimates of potential output based on production theory. Under the common definition, potential output measures aggregate output produced and used in economic conditions devoid of upward or downward demand-side pressure on prices.

In concrete terms, in the calculation presented here, participants in professional development measures and employment and professional integration measures implemented by employment agencies are counted towards the potential labour force. The average for the last 15 years is estimated, mimicking a situation of normal utilisation of production capacities. That average is around 300,000 people.

We will now explain the origin-based method of calculating potential labour force, followed by a discussion of working time components. These two components are then related to the potential labour force in full-time equivalents.

2.1 Measuring and projecting the potential labour force

The potential labour force is measured on the basis of the resident working-age population which is divided into sub-categories in a manner that appropriately reflects relevant differences with regard to their potential participation in working life. Labour force participation differs primarily by age and gender. Furthermore, in this calculation method, a distinction is also made depending on whether the people are living permanently in Germany or are migrants who immigrated a short time ago and wish to remain in Germany only on a temporary basis. In contrast to the IAB estimate of the potential labour force (Fuchs and Dörfler, 2005; Fuchs and Söhnlein, 2005), citizenship is irrelevant. In this respect, rather than naturalisation, it is the length of time for which they have lived in Germany that determines when the immigrant groups make the transition to the permanent resident population.

The permanent resident population is broken down by gender. As long as immigrants fall within the migrant categories, the gender has no bearing on labour force participation for the purposes of the model. Rather, immigrants are differentiated according to whether their migration decision was motivated chiefly by the aim of participating in working life in this country or whether other motives (such as uniting a family, asylum) were the primary factors. The creation and conceptual delimitation of migrant groups is necessitated by the fact that labour force participation is systematically higher among labour migrants and systematically lower among other migrants than among the permanent resident population. After even a relatively short period in the country, labour force participation among migrants may adapt in that they are taking more steps towards staying on a longer-term basis and the migrants' general circumstances are becoming similar to those of the permanent resident population, e.g. as a result of their family moving here to join them.[7] In the course of this adjustment, the gender of the immigrants is also likely to become more relevant in terms of the decision to participate in working life,[8] whereas when they first arrive in the host country, the reason for immigrating exerts the greatest influence.

[7] In this context, we are not talking about a convergence in educational status – aside from improved language skills – or of other forms of assimilation which tend to have a long-run impact on employment opportunities.

[8] The calculations assume that a slight majority of the immigrants (55%) is male.

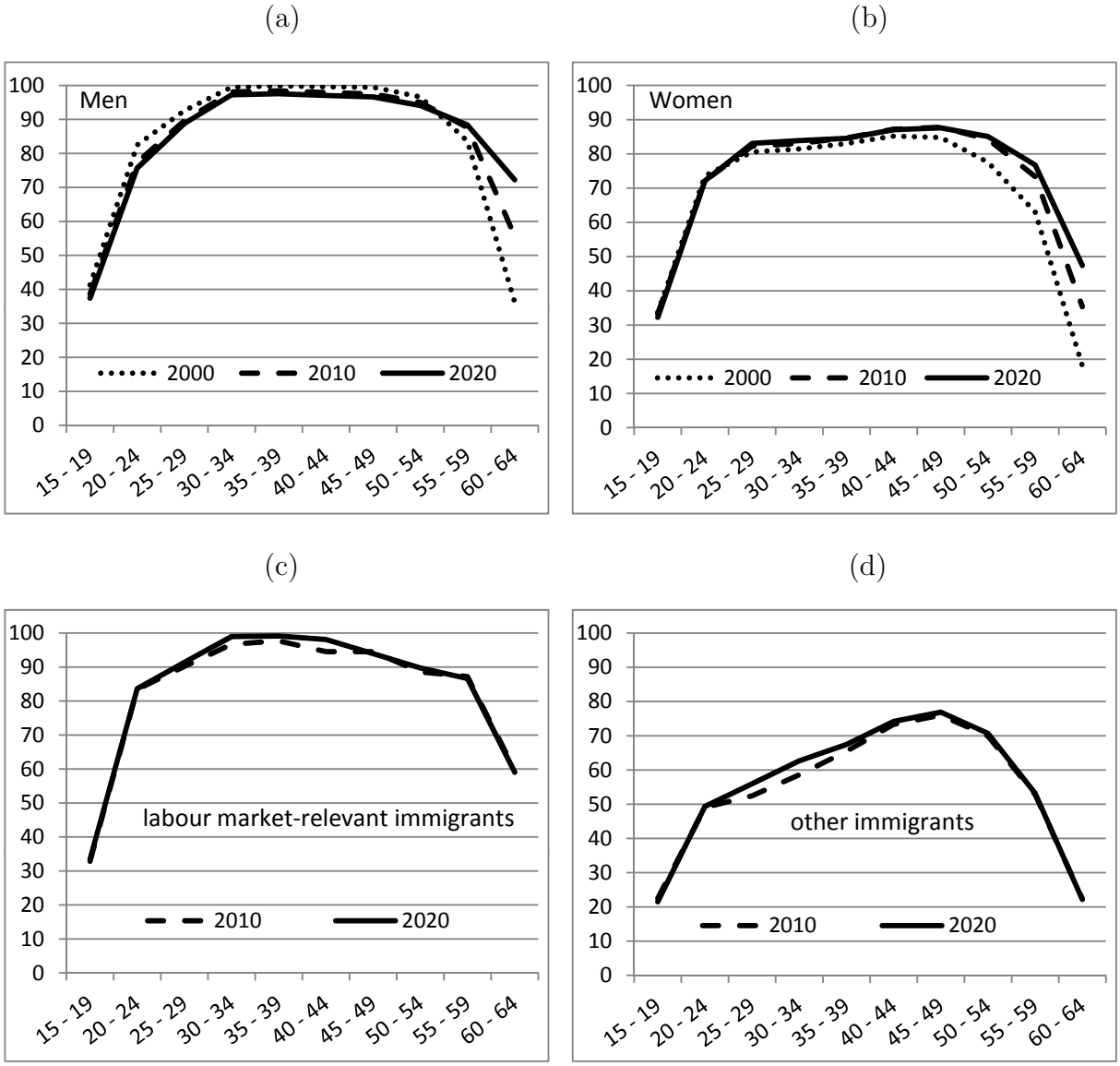

Figure 2: Potential labour force participation rates (as % of resident population)

Immigration is measured according to the net concept, whereby the migration surpluses increase the resident population until their death. Each net migration vintage initially becomes a full part of the migrant groups, but gradually makes the transition to the permanent resident population. We assume that the transition process lasts eight years, with the majority of transitions (approximately 60%) occurring between the third and sixth year of living in the country.[9] Whilst the approach based on the balance of migration

[9]In precise terms, the transition process is modelled by the logistic function $Y(t+\tau) = X_\tau(t)/[1 + e^{-4/3(\tau-4)}]$, where $X_\tau(t)$ is the portion of the migration surplus for the period t that survives for τ years and $Y(t+\tau)$ denotes the number of transfers in period $t+\tau$ from the migration vintage t. The modelling

flows neglects the age structure effects of the "basic migration flow" (i.e. the minimum of inward and outward migrations), it does make the modelling considerably easier as, if gross flows were used, the distribution of emigration among individual groups of people would have to be specified. Consequently, the data relating to migrant groups for one period are derived entirely from the migration surpluses of the previous eight years, which means the numbers are very small compared with the male and female permanent resident population.

The population model used in the estimate procedure comprises the following categories (shares of the total population indicated in parentheses):

I. male permanent resident population ($49\frac{1}{2}\%$)

II. female permanent resident population ($48\frac{1}{2}\%$)

III. labour market-relevant immigrants ($1\frac{1}{2}\%$)

IV. other immigrants ($\frac{1}{2}\%$)

In each population category, eleven age cohorts are defined, splitting total, potential working life into five-year segments, i.e. 15-19 years, 20-24 years, ..., 60-64 years, 65 or older. For the projections, the age structure in the individual groups is taken from the mortality assumptions in the 12th coordinated population projection (StaBu, 2009).[10] The cohort survival method is used here; it is also commonly used in the official population projections (Bretz, 2000). Level shifts account for the discrepancies between the population extrapolation and the census results revealed by *Zensus 2011* (StaBu, 2013).

The extent and the age structure of net immigration are estimated along with the distribution by labour market-induced and other immigration, taking the likely labour market differences between Germany and the possible countries of origin as well as historical patterns as the points of reference. The current situation is probably typified by an overwhelming predominance in the migration surplus of people who will participate directly in working life. The baseline projection assumes annual migration growth of between 300,000 and 150,000 people until 2020. Of that number, it is assumed that three quarters will be directly available to the labour market. Based on the age distribution of net immigration in the latest years, 2010 and 2011, for which statistics were recorded, the surpluses chiefly comprise the younger age groups, whilst in the age groups of 40 years and over, immigration and emigration have largely balanced each other out. Various scenarios make allowance for the uncertainty that surrounds migration assumptions.

For each age group a, $a = 1, ..., 11$, of the population categories under consideration i, $i = \mathrm{I}, \mathrm{II}, \mathrm{III}, \mathrm{IV}$, a potential labour force participation rate p_a^i is assumed which may change over time. Based on the IAB concept (Fuchs and Dörfler, 2005) the potential labour force participation rate relates all three distribution-side components of labour

method is based on plausibility considerations; the authors are not aware of any research findings that could provide an empirical basis for this type of adjustment process.

[10] As the projection horizon is limited to ten years, the assumptions on birth rate have no relevance.

force participation to the population in the respective sub-segment, whereas the labour force participation rates in the *Mikrozensus* only comprise the employed and unemployed persons. Nevertheless, the latter form the empirical basis for deducing the age and population category-specific potential labour force participation rates and an estimated figure for the contribution of the inactive employable population is added to that.

Figs. 2(a) to (d) document the age profile of the potential labour force participation rates for the four population categories.[11] Estimated values for the baseline are shown for 2000, 2010 and 2020.[12] One important assumption is that, in the 60-65 year age group, participation in working life is likely to increase. In this group, labour force participation has already more than doubled between 2000 and 2010 although, at around 44%, it remains on the low side.[13] It is assumed that this figure will rise to around 58% by 2017 and thereafter remain constant. Furthermore we expect a slight increase in labour force participation among middle-aged women, as further measures will be taken to facilitate combining a career with a family, such as the expansion of childcare facilities. It is only in the age group of 15-19 year-olds that we are assuming a slight decline in labour force participation, based on the notion that participation in education will continue to increase, with more people gaining higher qualifications.

Among migrants, labour force participation depends very heavily on whether they come to Germany primarily for professional reasons, or have other motives. Labour force participation among the category that comes with the goal of finding a job in Germany is only slightly below that of the male permanent resident population, but is growing over time. Labour force participation among other migrants is significantly lower and we are assuming that it will remain so, despite rising in future.

The aggregate (headcount) potential labour force is calculated as

$$EPP(t) = \sum_{a=1}^{11} \sum_{i=\mathrm{I}}^{\mathrm{IV}} p_a^i(t) B_a^i(t), \tag{1}$$

where B_a^i denotes the number of people in the age group a in population category i and t denotes the time index.

Figs. 3(a) and (b) show the trend in potential labour force until 2020 in the baseline projection and illustrate the sensitivity if various alternate assumptions are made. In both charts, the migration assumptions are uniformly varied, i.e. in addition to the migration balance in the baseline projection, this balance when multiplied by 0.5 and 1.5 times is

[11] The raw data are the age-specific participation rates from the *Mikrozensus*, the reference categories having been chosen as follows: all male persons for I; all female persons for II; men who have moved to the country in the last 5 years for III; women who have moved to the country in the last 5 years for IV. The raw data are adjusted to take account of the difference between actual and potential participation in working life and to allow for statistical inaccuracies in connection with the reporting of the data during the *Mikrozensus* (e.g. under-reporting of marginal employment).

[12] For the projection period, the potential labour force participation rates are those which we deem most likely to occur.

[13] Labour force participation among this age group is well over 50% in the Northern European countries, for instance.

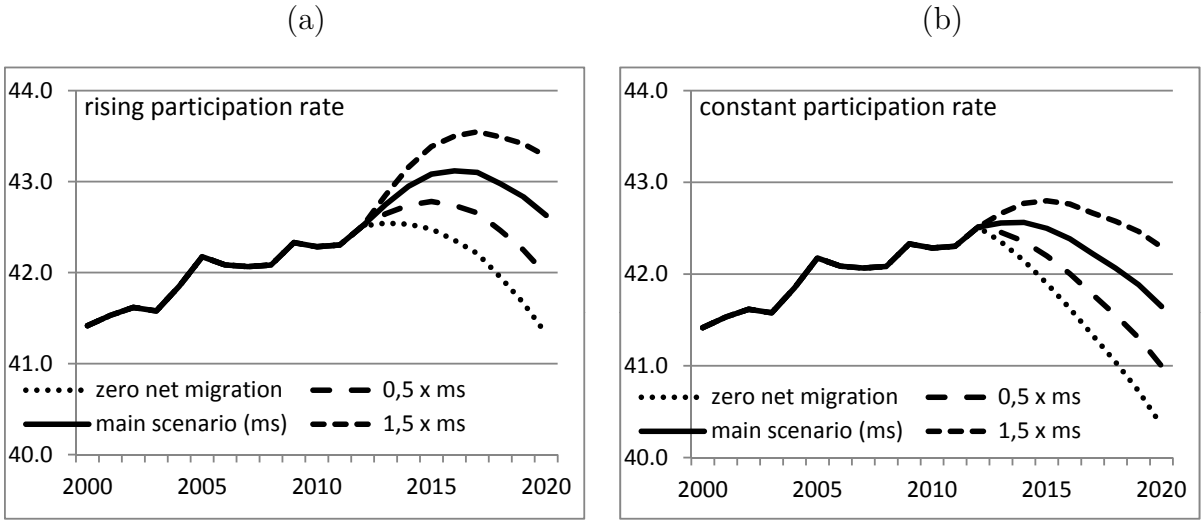

Figure 3: Headcount potential labour force (in million persons)

also considered.[14] There are also calculations based on a steady zero migration surplus ("zero scenario"). Fig. 3(a) depicts the development of the potential labour force assuming the increase in labour force participation outlined above, whilst Fig. 3(b) is based on the assumption of constant age and population category-specific participation rates which are affected only by shifting age structures and immigration.

In 2012 the potential labour force was $42\frac{1}{2}$ million people, which equates to four-fifths of the working-age population. In the baseline scenario, after trending sideways in the second half of the last decade, the potential labour force will increase slightly by $\frac{1}{2}$ million by 2016. The assumed migration surplus will subsequently no longer be sufficient to offset the declining natural population movement. By 2020, the potential labour force would nonetheless exceed the current level marginally. If the migration balance were in equilibrium, the potential labour force would fall over the course of the current decade – at an increasingly rising rate from 2015 onwards (in absolute value).

In the baseline scenario, the downward trend in the potential labour force is also mitigated by the further rise in age and population category-specific participation in working life. This can be illustrated by the fact that, assuming participation rates be constant over time, the potential labour force would fall by $\frac{3}{4}$ million people by 2020 *ceteris paribus*. Even if the migration balance is 1.5 times greater than assumed in the baseline scenario, at the end of the projection horizon a drop of $\frac{1}{4}$ million people would be recorded.

[14]The age structure of immigration and its distribution in regard to labour market-induced or other migration is not altered.

2.2 Measuring and projecting the working time factor and the potential labour force in full-time equivalents

The potential labour force in full-time equivalents in the period t can, like (1), be calculated as follows:

$$EPP^V(t) = \sum_{a=1}^{11} \sum_{i=\mathrm{I}}^{\mathrm{IV}} w_a^i(t) p_a^i(t) B_a^i(t). \tag{2}$$

The working time factor w_a^i in age group a of population category i is defined as

$$w_a^i(t) = \frac{[1 - q_a^i(t)]V_a^i(t) + q_a^i(t)T_a^i(t)}{V_a^i(t)}, \quad 0 < w_a^i \leq 1, \tag{3}$$

where q_a^i is the part-time employment rate of the sub-category designated by i and a. V_a^i and T_a^i denote, respectively, the age and population category-specific full-time or part-time working hours standardly worked or preferred in normal economic conditions.[15]

The inclination towards part-time work and working time preferences vary not only by age and population category, but are also likely to depend on whether the person is employed, unemployed or not actively seeking work at present.[16] In this respect, among the working population differences between employees and the self-employed (including unpaid family workers) are empirically relevant. The working time factors specific to the different age groups and population categories are thus determined as the weighted total of the corresponding working time factors for employees, the self-employed, the unemployed and employable people who are not actively seeking work.[17]

Working times are estimated assuming cyclical normal capacity utilisation. From a conceptual perspective, it is also advisable to measure potential labour supply on the basis of preferred working hours, if the number of hours actually worked is limited from the demand side.[18] To do this, however, we must refer to survey data which are of limited reliability in some sub-segments due to the low number of cases.

The IAB's working time calculation is used to calculate the working time factors for **employees**.[19] This reports part-time employment rates by age and gender, while also recording the actual working hours for various components (e.g. sick leave, overtime, working time accounts, short-time work, strikes), based on the working weeks stipulated in collective labour agreements or by individual companies. The standard or company-specific working hours are not generally the same as the weekly hours worked in cyclically

[15] The maximum $w_a^i = 1$ is reached when all the people in the corresponding age group and population category are working full-time. The factor w_a^i is smaller, the higher the rate of part-time working and the greater the difference between the working hours of full and part-time workers.

[16] A similar method can be found in Wanger et al. (2013).

[17] Employees carry by far the greatest weight (80.4% on average across all age groups and both genders), followed by the self-employed (10.3%), unemployed (8.6%) and people participating in labour market programmes who are part of the hidden labour reserve (0.7%).

[18] Full-time workers prefer to work less hours than they actually do. In the case of full-time workers, the hours actually worked are considered.

[19] The IAB's working time calculation is described in Wanger (2011).

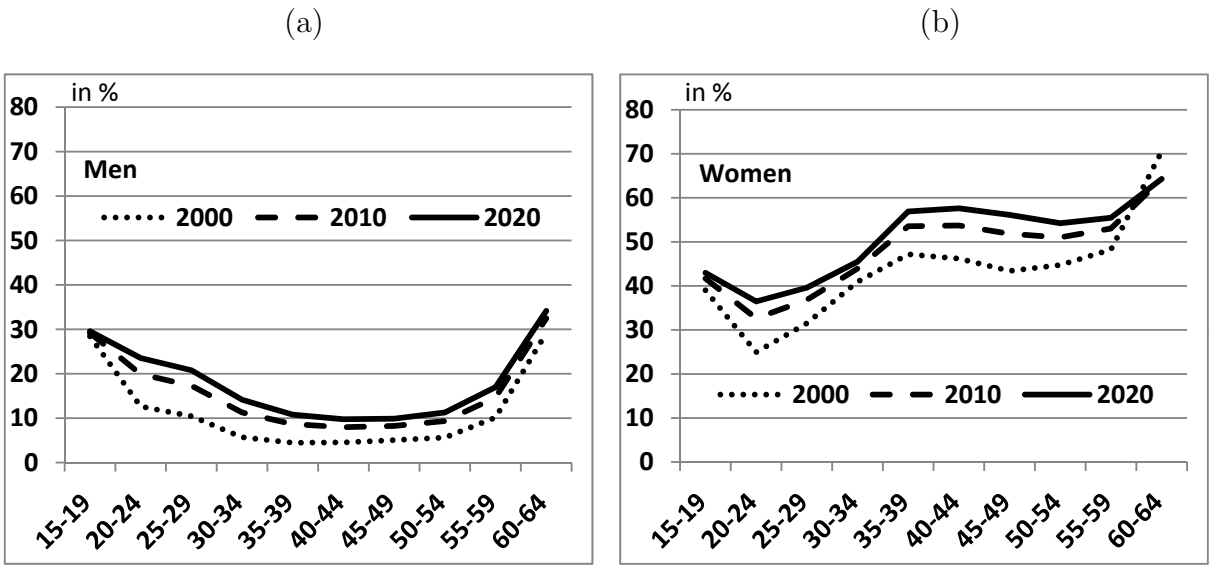

Figure 4: Part-time shares (as % of total employment)

normal conditions. The latter must take account of the average volume of overtime work. Moreover, standard working hours may be reduced because of economic conditions – as happened during the financial and economic crisis in 2008/09 (see, for example, Bbk, 2010).

The *Mikrozensus* is a source of data on actual weekly hours worked, broken down into full-time and part-time workers. The SOEP contains data on preferred and agreed working hours. Based on this, additions and deductions are calculated which are then added to the results of the *Mikrozensus*.

Figs. 4(a) and (b) illustrate the age-specific part-time employment rates of male and female employees for the years 2000, 2010 and 2020 (baseline projection); the definition of a full-time position is a working week of at least 35 hours. For men and women, the part-time employment rate is comparatively high among 15-19 year-olds. This is because, at this age, education and professional development are frequently combined with working reduced hours. While the part-time employment rate for men steadily falls in the subsequent age groups, remaining at a very low level in the fourth and fifth decades of life, the percentage of women in part-time employment rises to more than half during the phase when they are starting a family. The highest rate of part-time employment in the age profile is measured in the period prior to retiring, for both men and women.

Between 2000 and 2010, the part-time employment rate increased for both genders in all age groups below 60 years. Among 60-64 year-olds, a slight decline in part-time employment rates can now be observed, although the rate is very high in this age group. The decline could be partly due to a number of government-funded early retirement schemes coming to an end in the last few years, and fewer new partial retirement schemes being launched. The baseline projection assumes that part-time employment rates will continue to rise – albeit at a slower pace than was the case in the last decade.

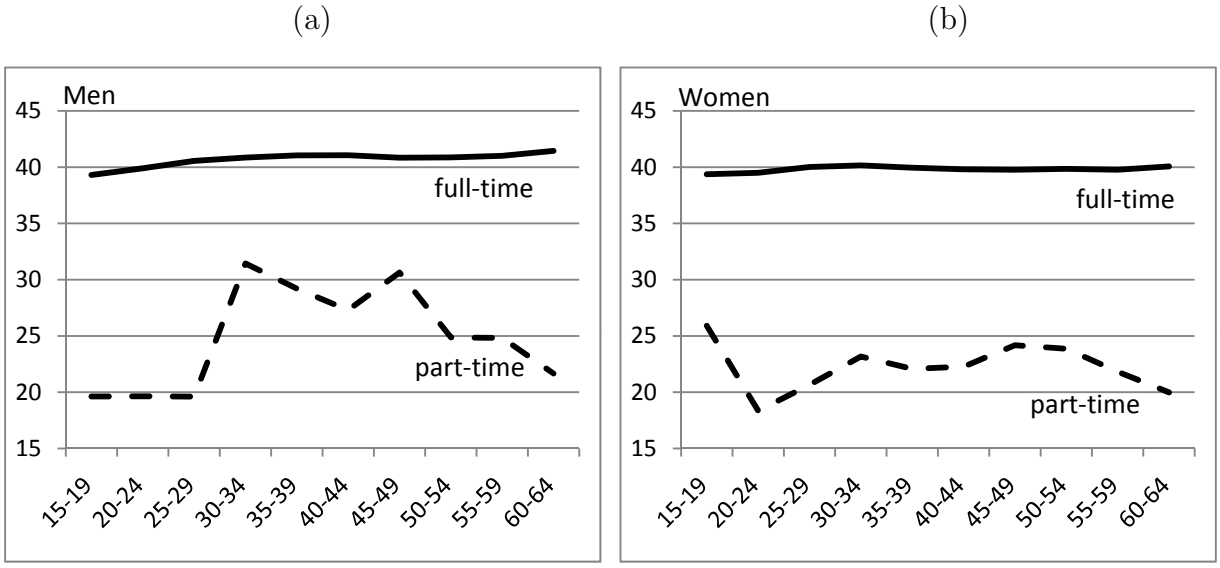

Figure 5: Weekly hours worked in 2010

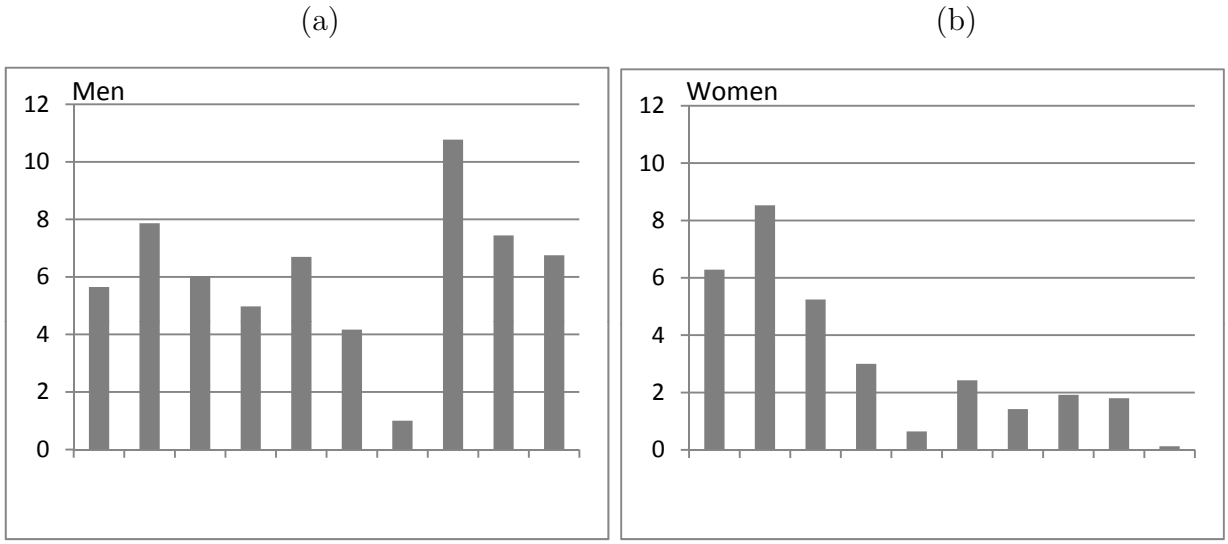

Figure 6: Difference between preferred weekly working hours and weekly hours worked by part-time workers (in hours)

As can be seen in Figs. 5(a) and (b), the average working week of full-time workers does not differ by gender or age group. Furthermore, there has been little change in recent years. Among part-time workers, however, there are marked age and gender-specific differences. Disregarding the under-20s, we see hump-shaped age profiles for both genders, with middle-aged male part-timers working considerably more hours than their female

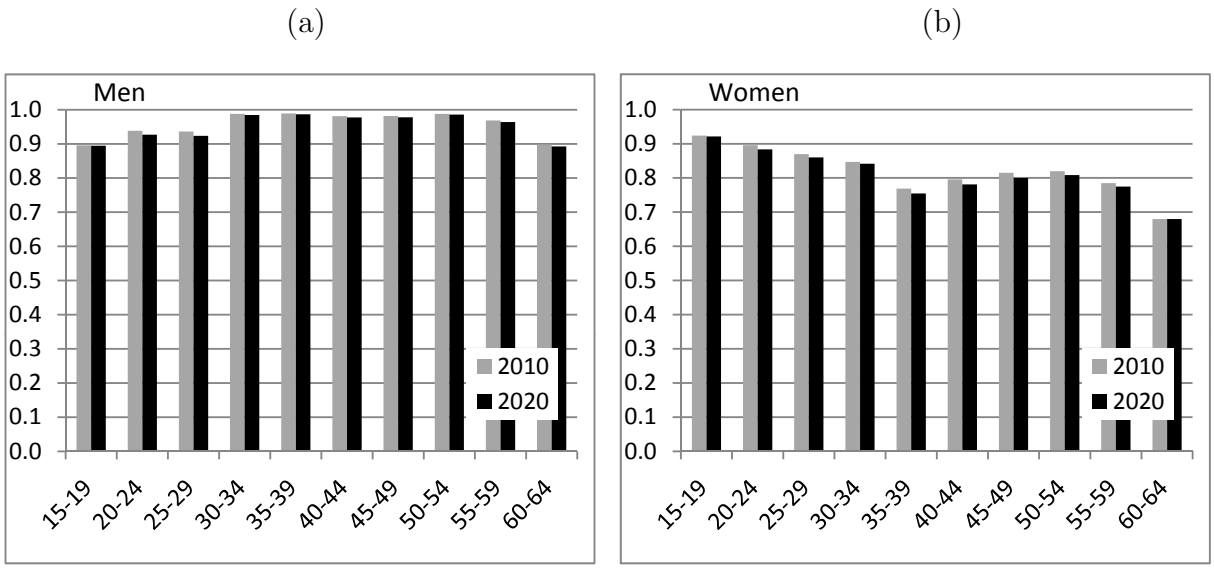

Figure 7: Working time factors

counterparts. Between 1995 and 2001, according to the SOEP part-time working weeks reduced by approximately $3\frac{1}{2}$ hours per week and the figure has remained at around 23 hours since. It is the middle age categories who work the most hours, whilst younger part-timers work only around 16 hours. Figs. 6(a) and (b) show that both male and female part-timers, would ideally like to work more hours.

Part-time working is far less common among **the self-employed** than employees. The gender distribution and the corresponding age profiles are taken from the *Mikrozensus*. As there are no identifiable trends in the waves under consideration, the figures from 2007 are updated in subsequent years and over the projection horizon.

To calculate the working time factor of **the unemployed** and **people not actively seeking work**, assumptions must be made about the employment circumstances ideally sought and the preferred working hours. To do this, we use the SOEP to ascertain the full-time or part-time employment sought by unemployed people. The working hours used correspond to those of employees.

Figs. 7(a) and (b) document the age and gender-specific working time factors for the years 2010 and 2020, calculated according to (3) on the basis of the data and assumptions mentioned and aggregated over the distribution-side components of the potential labour force. The working time factor for men is generally higher than for women and is almost unity in the age groups between 30 and 60 years. This can be ascribed chiefly to the very low part-time employment rate among men in this stage of life. Among women, the under-20s have the highest working time factor (0.9); between the ages of 20 and 40, this falls steadily to 0.75 and then goes back up slightly in the fifth and sixth decade of life. The lowest working time factor for both genders is measured at the upper end of the age distribution. Among men it is 0.9; among women it is just under 0.7. In the baseline

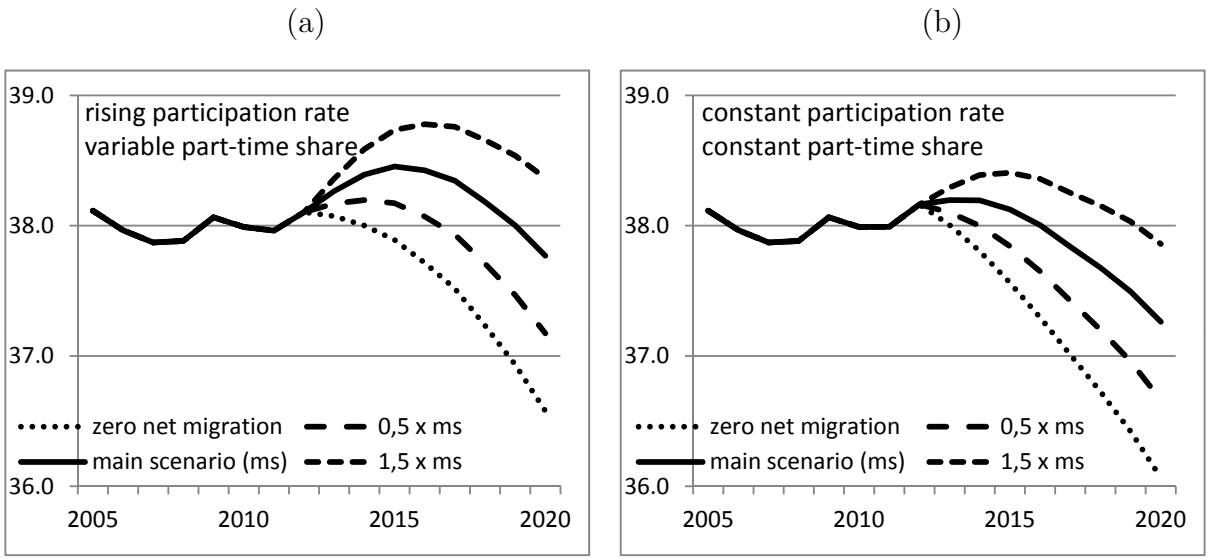

Figure 8: Potential labour force in full-time equivalents (in million persons)

projection, the working time factor consistently drops compared with 2010. This reflects the assumption that the rate of part-time employment among employed people will rise further.

The development of the potential labour force in full-time equivalents is visibly influenced by the negative working time effect. Fig. 8(a) shows that the increase in the headcount potential labour force until 2016 is only half the size when viewed in full-time equivalents. For the end of the projection horizon, a drop of $1\frac{1}{4}\%$ compared with 2012 is to be expected. In the hypothetical scenario of no change in labour force participation and working time, there would be a decline of almost $2\frac{1}{2}\%$ (see Fig. 8(b)).

The working time effect is a causal factor in rising labour force participation, because the assumption is that older people will remain in work for longer and labour force participation among people with family commitments will increase if they work reduced hours.[20] The net effect on labour supply, which is ultimately what we are interested in, can be quantified using analytical tools which are discussed in Section 3.1.

3 Applications

This section looks at two applications of the potential labour force in full-time equivalents. Firstly, it introduces a method of calculating the ageing effect on labour supply. Secondly, it explains the conditions in which the disaggregated estimate of the potential labour force in full-time equivalents can be used to determine the labour input in macroeconomic production functions.

[20]Because of this, in the case of potential labour force in full-time equivalents it makes no sense to calculate alternative scenarios with constant labour force participation rates.

3.1 Ageing effects on labour supply

The age structure of the population influences the aggregate labour supply in two ways. Firstly, due to differences in the age profile of labour force participation, and secondly because working hours differ between age groups. The (headcount) potential labour force is used to calculate the impact of the participation channel. The overall effect of both channels can be ascertained on the basis of the potential labour force in full-time equivalents.

For the following analysis, the defining equations for both concepts are simplified so that the summation based on population categories is eliminated. Therefore:

$$EPP(t) = \sum_a p_a(t) B_a(t), \tag{1'}$$

$$EPP^V(t) = \sum_a w_a(t) p_a(t) B_a(t). \tag{2'}$$

The number of all age groups across which the summation is done is denoted by A.

The mean potential labour force participation rate among the resident population p is obtained from (1′) divided by the population $B = \sum_a B_a$:

$$p(t) = \frac{EPP(t)}{B(t)} = \sum_a \beta_a(t) p_a(t), \tag{4}$$

where $\beta_a = B_a/B$, $0 \leq \beta_a \leq 1$ is the share of the age group a in the total population. Similarly, the mean standardised potential labour force participation rate π is defined as

$$\pi(t) = \frac{EPP^V(t)}{B(t)} = \sum_a \beta_a(t) \pi_a(t) \tag{4a}$$

with $\pi_a = w_a p_a$. The participation rates are standardised in regard to the standard working hours of a full-time worker.

The effects created by the change in age structure, i.e. shifts in the vector $\{\beta_1, \beta_2, ..., \beta_A\}$, over time on p and π can be decomposed by a "shift-share analysis". Differentiating (4) and (4a) by time yields ultimately:

$$\frac{d\,p(t)/d\,t}{p(t)} = \sum_a g_a(t) \frac{d\,p_a(t)/d\,t}{p_a(t)} + \sum_a g_a(t) \frac{d\,\beta_a(t)/d\,t}{\beta_a(t)} \quad \text{with} \quad g_a(t) = \frac{\beta_a(t) p_a(t)}{p(t)}, \tag{5}$$

$$\frac{d\,\pi(t)/d\,t}{\pi(t)} = \sum_a \gamma_a(t) \frac{d\,\pi_a(t)/d\,t}{\pi_a(t)} + \sum_a \gamma_a(t) \frac{d\,\beta_a(t)/d\,t}{\beta_a(t)} \quad \text{with} \quad \gamma_a(t) = \frac{\beta_a(t) \pi_a(t)}{\pi(t)}. \tag{5a}$$

The ageing effect is depicted in the equation by the second term in each case. Because of $g_a \neq \gamma_a$ in general, the standardised and non-standardised potential labour force participation rates are differently affected by the changes in the age distribution of the population.

(a) (b)

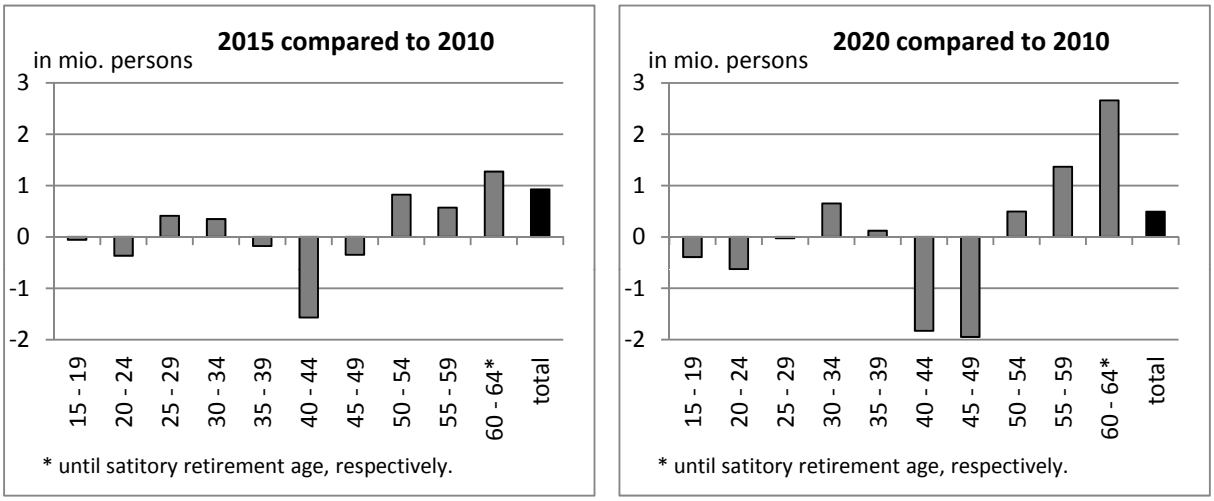

Figure 9: Change in resident population by age groups (in millions)

(a) (b)

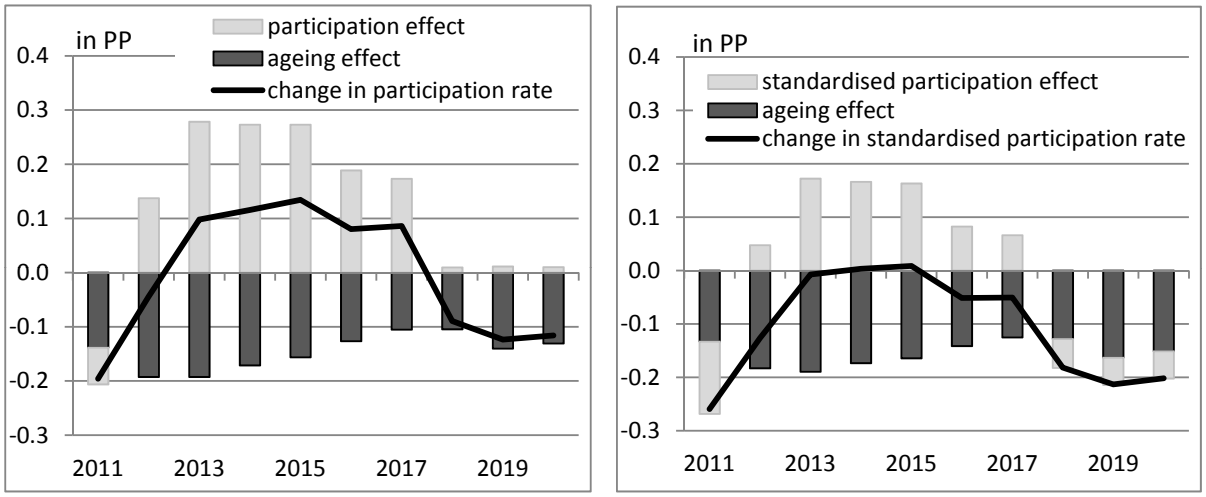

Figure 10: Decomposition of the change in the (standardised) potential labour force participation rate

Figs. 9(a) and (b) document the shifts in the population's age structure until 2015 and 2020. In these years, the percentage of people who are in the decade of life prior to retirement will be far higher than in 2010. This will be chiefly at the expense of those aged 40-49. It must be borne in mind that immigration per se lowers the age of the population. In the calculation here, this effect is added to the ageing effect, whilst in the decomposition of Fuchs (2009) it is regarded as part of the migration effect.

The shift gives rise to a negative ageing effect on the mean potential labour force participation rate which, in the projection period, is 0.1 to 0.2 percentage point per year (see Fig. 10(a)). The effect can be attributed to the fact the substantial differentials in labour force participation between the age groups concerned will persist though it will flatten out somewhat. According to the baseline projection, from 2018 the aggregated potential labour force participation rate will fall as the ageing effect will continue to have an impact. However, the assumption is that it will no longer cause a significant increase in labour force participation within the age groups and population categories.

In the baseline scenario, the mean standardised potential labour force participation rate no longer rises (see Fig. 10(b)). In this case, until 2015 the ageing effect is virtually equal to the participation effect which, because the working time factor is taken into account, is lower than for the non-standardised potential labour force participation rate. Hence, the standardised potential labour force participation rate would decline. From 2018, this decline would be 0.2 percentage point a year.

3.2 Supply-side calculation of trend hours worked

From a supply-side perspective, the trend in hours worked AV, which is normally used in aggregated production functions as the measure of labour input, can be broken down as follows:

$$AV(t) = \frac{AV(t)}{ET(t)} \frac{ET(t)}{EPP(t)} \frac{EPP(t)}{B(t)} B(t) = \tilde{W}(t)\, e(t)\, p(t)\, B(t), \tag{6}$$

where $\tilde{W}$ denotes the cyclically adjusted working time averaged over the number of employed persons ET with cyclical normal capacity utilisation and e the cyclically adjusted employment rate.[21]

One important application of this concept is when estimating potential output.[22] The prevailing practice at present, based on the Solow (1957) growth model, relies not on the level but rather the trend change in hours worked:

$$\frac{d\,AV(t)/d\,t}{AV(t)} = \frac{d\,\tilde{W}(t)/d\,t}{\tilde{W}(t)} + \frac{d\,e(t)/d\,t}{e(t)} + \frac{d\,p(t)/d\,t}{p(t)} + \frac{d\,B(t)/d\,t}{B(t)}. \tag{7}$$

Recalling (4), it is clear that the rate of change in the potential labour force can be substituted for the latter two terms. However, if the potential labour force in full-time equivalents is used, additional assumptions have to be made which are discussed below.

The average working time of the employed is obtained from the weighted average of the working times of full-time and part-time workers and the aggregation of all age groups:

$$\tilde{W}(t) = \sum_a \tilde{\delta}_a(t) \tilde{W}_a(t) \quad \text{mit} \quad \tilde{W}_a(t) = [1 - \tilde{q}_a(t)]\, \tilde{V}_a(t) + \tilde{q}_a(t)\, \tilde{T}_a(t), \tag{8}$$

[21] Hereafter all measures which relate to employment are indicated by a tilde ($\sim$).

[22] See Bbk (2012) and D'Auria et al. (2010), for istance. The second reference contains a description of the European Commission's estimation technique which German government agencies are required to use to calculate the output gap when determining the impact of economic conditions on net borrowing.

where $\tilde{\delta}_a = ET_a/ET$ represents the share of employed in age group a as a percentage of total employment.

The aggregation rule for the working time factor defined in (3) is as follows:

$$w(t) = \sum_a \delta_a(t) \frac{W_a(t)}{V_a(t)} \quad \text{mit} \quad W_a(t) = [1 - q_a(t)]\, V_a(t) + q_a(t)\, T_a(t), \tag{9}$$

where $\delta_a = EPP_a/EPP$ is the weighting of the age group a in the potential labour force. This entity – and not employment as in (8) – is the reference for q_a, V_a, T_a and W_a.

The rates of change in average working time of the employed and the aggregated working time factor are obtained from the total differential of the equations (8) and (9), respectively. After some rearranging, this produces the following equations:

$$\frac{d\,\tilde{W}(t)/d\,t}{\tilde{W}(t)} = \sum_a \tilde{\delta}_a(t) \frac{\tilde{W}_a(t)}{\tilde{W}(t)} \left[\frac{d\,\tilde{\delta}_a(t)/d\,t}{\tilde{\delta}_a(t)} + \frac{d\,\tilde{W}_a(t)/d\,t}{\tilde{W}_a(t)} \right], \tag{10}$$

$$\frac{d\,w(t)/d\,t}{w(t)} = \sum_a \delta_a(t) \frac{W_a(t)/V_a(t)}{w(t)} \left[\frac{d\,\delta_a(t)/d\,t}{\delta_a(t)} + \frac{d\,W_a(t)/d\,t}{W_a(t)} - \frac{d\,V_a(t)/d\,t}{V_a(t)} \right]. \tag{11}$$

If we compare the two equations, it becomes clear that

$$\frac{d\,\tilde{W}(t)/d\,t}{\tilde{W}(t)} = \frac{d\,w(t)/d\,t}{w(t)} \text{ as a prerequisite for } \frac{d\,AV(t)/d\,t}{AV(t)} = \frac{d\,EPP^V(t)/d\,t}{EPP^V(t)} + \frac{d\,e(t)/d\,t}{e(t)}$$

only applies if the following conditions are met:

(i) The age structure of employment is identical to that of the potential labour force in every period. The same is true of the age profile of the rate of part-time employment and the standard working hours of full-time and part-time workers: $\delta_a(t) = \tilde{\delta}_a(t)$, $q_a(t) = \tilde{q}_a(t)$, $V_a(t) = \tilde{V}_a(t)$, $T_a(t) = \tilde{T}_a(t)$ for all a and t.

(ii) There is no variation in the standard working hours of full-time workers across the age groups: $V_a(t) = V(t)$ for all a.

(iii) The number of standard working hours of full-time workers remains constant over time: $V(t) = V$ for all t.

When assessing the relevance of condition (i) it must be remembered that practitioners often set $e(t) = 1 - u^*(t)$, where u^* is regarded as the NAIRU (i.e. non-accelerating inflation rate of unemployment).[23] A macroeconomic concept is used which is created to estimate

[23] From a conceptual perspective, this is inaccurate in that the employment rate refers to the potential labour force but NAIRU is expressed as a percentage of the (effective) labour force. The imputed difference, however, is immaterial: it is 0.7% of the potential labour force (see section 2.1). By construction, this barely fluctuates, and thus has no adverse effect on the (ultimately relevant) approach based on rates of change over time. NAIRU estimates for Germany, which are based on a Phillips curve relationship, are presented in Kajuth (2010) among others.

Table 1: Decomposition of the annual change in trend hours worked

period	trend hours worked*	potential labour force in full-time equivalents*	standard working hours of full-time workers*	NAIRU†
2001 – 2005	0.1	0.1	0.0	0.0
2006 – 2010	0.3	-0.1	0.0	0.3
2011 – 2015	0.4	0.2	0.0	0.2
2016 – 2020	-0.3	-0.4	0.0	0.0

* Average annual percentage change
† Average NAIRU change in percentage points with reverse sign

the change over time, whereas differences in the employment rate that are attributable to age are irrelevant. In light of this, it seems appropriate to rely on the age-specific structure and working time information of the potential labour force (and not of employment) in the supply-side model for trend hours worked.

Bearing in mind the findings from Fig. 5(a) and (b), the condition (ii) can be deemed to be met. There is, however, no justification for deeming condition (iii) to be met – certainly not with regard to the past when, for a long time, there was a trend towards shorter working hours.

If conditions (i) and (ii) hold, however, the following approximation can be derived from (7) for small u^*:

$$\frac{d\,AV(t)/d\,t}{AV(t)} \approx \frac{d\,EPP^V(t)/d\,t}{EPP^V(t)} + \frac{d\,V(t)/d\,t}{V(t)} - [d\,u^*/d\,t]. \tag{12}$$

The change in trend hours worked (in percent) is thus the total of the percentage changes in the potential labour force in full-time equivalents and the standard working hours of full-time workers, adjusted for the NAIRU percentage change.

Of the supply-side factors in the change of labour input in production functions, potential labour force in full-time equivalents takes full account of the demographic changes and the shifts in labour force participation. Moreover, structural changes in standard working hours are included relative to the hours worked by full-time workers. Adjustments to the working time of full-time workers which have a lasting impact would have to be considered separately. This is also true of changes in the NAIRU.

Tab. 1 illustrates how the development of the trend hours worked in the last decade can be almost entirely described on the supply side by the potential labour force in full-time equivalents, as there were no changes in the standard working hours of full-time workers. This pattern is also assumed for the projection period to 2020. As a consequence of the Hartz reforms and the considerably greater flexibility that has existed in collective labour agreements since the first half of the last decade, the balancing mechanisms on the labour

market have greatly improved. This is reflected in a reduction in NAIRU between 2006 and 2010. Presumably this effect will remain palpable over the next five-year period. According to the estimates, the stimuli affecting trend hours worked which emanate from the increase in labour force participation and high levels of net immigration are of equally great quantitative significance in this period. For the second half of the current decade, however, the baseline projection predicts a palpable decline in the potential labour force in full-time equivalents, which is likely to be a determinant of the development of labour input in production functions.

4 Conclusions

The study focuses on assessing the trend in hours worked over the short to medium run from the supply side, with particular attention being paid to two aspects compared with the long-run projections prevalent in the relevant literature. Firstly, it takes a holistic view of labour force participation and working time, as these are often mutually determining factors in individual labour supply decisions. Secondly, it pays particular attention to the influence of migration on the supply side of the labour market. The proposed calculation method for determining the potential labour force is designed to depict migration scenarios in a flexible way. By converting the figures to full-time equivalents, we ensure that labour supply decisions are standardised in regard to working time.

The drawback of the measurement concept of potential labour force in full-time equivalents is that it only mirrors trend hours worked if the standard working hours of full-time workers are constant over time. At the start of the 1990s, this caveat was relevant in light of the extensive reductions in working hours stipulated by collective labour agreements, but in the projection period to 2020 that is the subject of this study, this condition is highly unlikely to have much relevance. The advantage of potential labour force in full-time equivalents is that it encompasses all components of hours worked that are characterised by an accentuated age profile (i.e. labour force participation, the part-time employment rate and the working time of part-time workers). Consequently, the overall effect of ageing on labour supply can be estimated.

The projections of the potential labour force and potential labour force in full-time equivalents presented here are based on many assumptions. Due to space constraints, the study concentrates on presenting the baseline scenario. It also looks at a select few alternative scenarios in order to illustrate the sensitivity of the projections to parameters that are relatively difficult to predict, such as immigration. However, the robustness of the estimates to all the assumptions and parameters used is not systematically evaluated. There are a number of techniques for doing this which are familiar from the analysis of the assumption dependency of population projections (Babel, 2007; Bomsdorf and Babel, 2007).

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