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Abstract

In this paper we investigate the recent fall in unemployment, and the rise in part-time work and labour market participation amongst prime-aged Germans. We show that unemployment fell because the Hartz reforms induced a large fraction of the long-term unemployed to deregister as jobseekers. However, labour force participation actually increased because many female non-participants accepted low-paid, part-time jobs. Counterfactual simulations using estimated transition probabilities show that observed changes in the stocks of registered and unregistered unemployment as well as marginal, contributed part-time and full-time employment after 2002 essentially resulted from changes in registered and unregistered unemployment outflows. Yet to obtain the full decrease in registered male unemployment, we need to account for the effect of wage moderation. A calibrated Diamond-Mortensen-Pissarides model suggests that wage moderation is at most half as strong as the unemployment reforms in explaining changes in unemployment, non-participation and part-time employment.

JEL-Codes: J210, J310, J630, J640.

Keywords: unemployment, part-time work, mini-jobs, non-participation, wage moderation, Hartz reforms.

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1 Introduction

Since the mid-2000s, Germany has experienced one of the largest falls in unemployment seen in recent times. Figure 1 shows that after nearly two decades of persistently high levels, unemployment entered a downward trend in 2006, reaching its lowest level of 3.6% by the end of 2017. This decline started right after the implementation of the Hartz reforms (2003-2005), which aimed to make the labour market more flexible. Many economies with structurally high unemployment, such as France, have been called upon to do the same and adopt labour market deregulation policies. As a result, much work has been undertaken to understand the role (if any) the Hartz reforms played in reducing unemployment.[1] Many of these studies find support for these reforms, but are inconclusive as to the degree of their success. Others are less positive on their effects and view wage moderation and the increased competitiveness of the German economy as the main drivers of economic growth and unemployment reduction (Dustmann et al., 2014).

In this paper we develop a simple yet insightful framework for studying the reduction of unemployment in Germany. We aim to provide a 'big picture' approach. Our framework considers all possible flows in and out of unemployment, non-participation and all forms of employment (full-time, part-time and marginal employment). Another originality is that we focus on prime-aged workers (25-54 years of age).

A key insight is that the reduction of unemployment did not happen through direct unemployment-employment flows, as is the focus of much of the literature. Unemployment fell because a greater fraction of unemployed workers did no longer register as jobseekers after the Hartz IV reform (2005), which reduced the duration of unemployment benefit payments, cut long-term unemployment benefits and imposed tighter conditions on welfare benefit recipients. Indeed, we find that a considerable proportion of the flows in and out of unemployment, and in and out of all forms of employment (marginal, contributing part-time and full-time) are with non-participation. Hence, many non-participants, that is workers who may not be seeking for a job on the day of the survey interview or may have decided not to show up at the job centres, must be actually still attached (marginally or loosely) to the labour market. Labour force participation actually rose after 2005 because increasingly more women have been taking up low quality, part-time jobs.[2]

Another key insight is that prime-aged men were the main losers from the labour market dynamics that occurred in Germany during the naughties and early 2010's. This insight, as far as we are aware, also has not yet been established or emphasised. Men were much less inclined than women to take up a part-time job and preferred to stay unemployed for longer. This resulted in a decrease in labour force participation for prime-aged men during the period of study. Adding unemployed and non-participants together, we find that the

[1] See for example Fahr and Sunde (2009), Klinger and Rothe (2012), Krause and Uhlig (2012), Krebs and Scheffel (2013), Launov and Wälde (2016), Burda (2016), Burda and Seele (2016).

[2] The parallel between increasing part-time and marginal employment (mini-jobs) on the one hand and falling unemployment on the other hand has already been documented elsewhere (Weinkopf, 2009, Burda, 2016, Burda and Seele, 2016, Rothe and Wälde, 2017, Biewen et al., 2017).

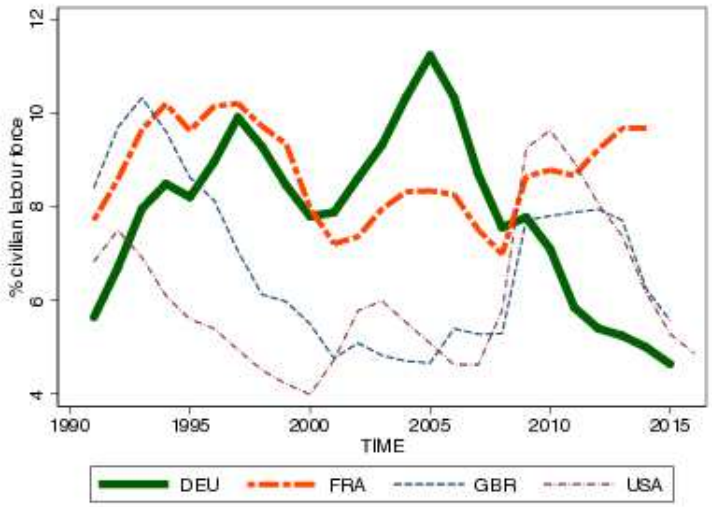


Figure 1: Unemployment as % civilian labour force

non-employment rate did not fall for prime-aged men after 2005. At the same time, full-time employment for this group had a very sluggish recovery after 2005, which ended after the financial crisis put it once again in a downward trend from which it is recovering only recently.[3]

Our focus on prime-aged workers is novel to the literature, which typically aggregates across all age groups without analysing and/or modelling older workers' retirement decisions and younger workers' decisions to work alongside education. Here we chose not to investigate these decisions or how they were affected by the reforms as we aim to provide as cleaner an analysis as possible. Since prime-aged worker represent about 65% of the German working population, we believe that our findings provide an important new angle on what happened in Germany after the Hartz reforms.

That many non-participants are in reality unregistered unemployed workers, and that they contribute to the dynamics of labour market flows is not new. For example, Gomes (2012), Jones and Riddell (1999) and Blanchard and Diamond (1990), among others, show that in the UK, Canada and the US there is a large proportion of marginally attached workers: those workers who are considered non-participants by statistical agencies but still want a job and exhibit very similar job finding rates as those labelled unemployed.[4] Elsby et al. (2015) further emphasise the importance of the non-participation margin in explaining unemployment fluctuations in the US. Barnichon and Figura (2016) find that the decline of those non-participants who declared wanting a job is behind the secular decline in the

[3]By focusing on prime-aged workers we miss the increase in labour market participation observed among older workers (55 - 65 years of age) after the introduction of Hartz I in 2003 and the stronger recovery the latter age group generated in overall full-time employment after the financial crisis. In Sections 3 and 6 we discuss the main consequences of adopting this restriction.

[4]A similar conclusion was recently drawn by Hall and Schulhofer-Wohl (2018): 'One of the key points of this paper is that the majority of job-seekers are not counted as unemployed, but rather as out of the labor force or employed. Despite Blanchard and Diamond's (1990) emphasis on this point, most analysis of the US labor market in the matching-function framework has taken unemployment as the measure of job-seeking in the population. An important exception is Veracierto (2011), [...].' See also Carrillo-Tudela et al. (2015).

US labour market participation. Here we show that this margin is important and must be taken into account when evaluating the effectiveness of labour market policies such as those aiming to bring people back to work through reductions in unemployment benefits and/or liberalisation of the low skill labour market.

While our flow analysis is interesting and original on its own, our paper provides one further contribution. Having estimated all transition probabilities at monthly frequency across all five states (registered and unregistered unemployment, and marginal, part-time and full-time employment), we proceed to a set of counterfactual simulations based on the statistical mobility model. We keep constant the transition probabilities as estimated in 2002, just before the Hartz reforms, and we introduce the changes to outbound probabilities from all five states separately.

We find that unemployment outflows tend to reduce unemployment and increase non-participation (or unregistered unemployment) but have no effect on employment stocks. Non-participation outflows entirely explain the rise of marginal and part-time employment as well as the rise of labour market participation. They do not affect registered unemployment or only to a small extent (for men). In order to obtain the full decrease in (registered) male unemployment, we need to add the changes to flows out of full-time employment. Specifically, job destruction is falling rather abruptly around 2003. This can be easily understood as a manifestation of the loss in the unions' bargaining power due to the liberalisation of the low skilled segment of the market (especially due to the facilitation of temporary work under Hartz I) and the ongoing process of wage moderation. Thus our counterfactual analysis suggests that both the Hartz reforms and wage moderation as well as their interaction played an important role in explaining the German labour market dynamics.

In the last section of this paper, we seek to quantify the effect of wage moderation relative to that of the Hartz reforms by constructing a stylised quantitative model. This is an almost impossible mission as labour market reforms and wage moderation were concomitant. Hence our model needs to be interpreted in this light. If one believes our modelling choice, then wage moderation is at most half as strong as the reforms in explaining changes in unemployment, non-participation and part-time employment. Interestingly, we also find that the Hartz reforms and wage moderation should have strongly increased full-time employment because matching efficiency increased and wage costs decreased. This did not happen in our data and the model accounts for this feature by increasing the cost of posting vacancies. The reason why we do not observe a large increase in full-time employment is due to our focus on prime-aged workers. Since the Hartz reforms, Germany has continuously reduced the incentives to early retirement. It may thus be that having to keep older workers at work longer increased the relative cost of hiring younger workers, in particular after the financial crisis.

There is a large literature focussing on various aspects of the Hartz reforms. We only mention here those papers which are mostly related to our own work. Rothe and Wälde (2017), Hartung et al. (2018) also proceed to an analysis of the flows in and out of unem-

ployment but miss out on the role of non-participation. Rothe and Wälde (2017) establish that direct transitions form unemployment to full-time employment have little quantitative importance, but do not uncover the role of non-participation as a transient state from unemployment to all forms of employment. Hartung et al. (2018) emphasise the reduction of the separation rate from employment to unemployment (which they attribute to Hartz IV) as the main culprit for the fall in unemployment. We show that by explicitly considering non-participation and different types of employment one gets a very different picture. Burda and Seele (2016) use the supply and demand framework of Katz and Murphy (1992) and conclude to a relative stable labour demand curve and an increasing labour supply, which they attribute to the Hartz reforms. They sort out two different types of causes and explain the expansion of part-time work, but, similarly to Rothe and Wälde (2017), do not explain the channel through which unemployed end up in part-time employment. Krause and Uhlig (2012), Krebs and Scheffel (2013), Launov and Wälde (2013, 2016), Hochmuth et al. (2019) design search and matching models that interpret the reduction of unemployment as the direct effect of the cuts in unemployment benefits induced by Hartz IV, which in their proposed search models can only increase search effort and/or job finding rates.

The rest of the paper is structured as follows. Section 2 describes the institutional background emphasising the role of the Hartz reforms and the datasets we use. Sections 3 and 4 describe the evolution of the stocks and flows, respectively. Section 5 uncovers the potential of monthly flows to predict long-run stocks and proceeds with counterfactual analysis based on estimated monthly transitions. In Section 6 we develop our theoretical framework and review the existing literature on structural evaluation of Hartz reforms and link it to our analysis. Section 7 concludes.

2 Preliminaries

2.1 Institutional background

The main institutional change that occurred during the period of study were the Hartz reforms. These reforms came in four packages. Many detailed descriptions exist in the literature (see for example Jacobi and Kluve, 2007, Fichtl, 2015). We briefly summarise their main content.

The Hartz I and III reforms were generally aimed at improving labour supply, and matching efficiency. Hartz I (1/1/2003) deregulated and enhanced temporary employment, introduced subsistence payments on behalf of the employment agency, and enhanced employment of elderly workers through employer subsidies. The latter mainly took the form of: a (i) social security subsidy, whereby a firm hiring a person older than 55 was exempt from paying contributions towards unemployment insurance, representing 3.25% of the gross wage; and a (ii) wage subsidy for hiring an older worker or a worker with disability, that amounted to 50% of calculable remuneration for a duration of 6 to 24 months (see Jacobi and Kluve, 2007).

Hartz III (1/1/2004) reorganised the Federal Employment Agency, improving in particular its efficiency in job offer mediation to unemployed workers.

The Hartz II package was introduced at the same time as Hartz I. It has reformed marginal employment and enhanced start-up subsidies to help long-term unemployed workers to become self-employed. Marginal employment was introduced in Germany in the sixties to help non-participants take up work. It is considered a form of low-pay employment with caps on hours and pay.[5] Workers in marginal employment are exempted from income tax and social security contributions, but are not entitled to unemployment benefits and obtain reduced pension payments at retirement. Firms, however, contribute to these worker's health insurance and pensions. In addition, unemployed workers who receive benefits are allowed to work in marginal employment to top up their benefits, as long as their jobs do not pay more than 165 euros per month. These mini-jobs are precarious, as they are used by firms to cover demand spikes. Moreover, employers reduce their costs by not paying marginally employed workers during holidays and sickness leave (Weinkopf, 2009).

Hartz II defined two types of marginal jobs: mini-jobs and midi-jobs. *Mini-jobs* paid up to 400 euros per month (450 euros in 2013), while *Midi-jobs* paid between 400 and 800 euros per month.[6] We highlight three modifications Hartz II introduced to the legal setup that governed the marginal employment sector. (i) It increased the maximal wage for mini-jobs from 325 to 400 euros. (ii) It eliminated the maximum limit of 15 working hours per week.[7] (iii) It extended the income tax and social security exemptions to mini-jobs held as a secondary job.[8]

Finally, Hartz II created the *Minijobzentrale*, a unique legal entity solely responsible for registering marginally employed workers and dealing with all tax and social security matters related to marginal workers and their employers. This made it easier for firms, from an administrative point of view, to set up marginal jobs and to pay the associated taxes and social security contributions. The flexibility that mini-jobs introduced to firm's hiring practices and the low set-up costs needed to create these jobs are important reasons why firms created mini-job opportunities after Hartz II. The *Minijobzentrale* also facilitated the systematic collection of data on marginal employment.

Hartz IV (1/1/2005) reformed the unemployment benefit system completely. It im-

[5]Throughout the 1980s and the 1990s this wage cap was set between one-fifth and one-seventh of the average gross national wage in the previous year. In April 1999 the German Federal Employment Agency set the wage cap to 325 euros per month.

[6]As in the pre-Hartz period, workers in mini-jobs paid no income tax and no social security contributions, while firms had to pay an increased contribution of 25% (and 30% in 2006) of an employee's gross earnings for health insurance, pensions and other taxes. Workers in midi-jobs paid reduced social security contributions and a linear income tax that ranged between 4% and 21%, while firms paid the full contribution rates to health insurance, pensions and income taxes.

[7]This hour limit was not lifted for those unemployed workers who in addition to their benefits received wages from a mini-job. See Caliendo and Wrohlich (2010) and Caliendo et al. (2016).

[8]Bundesgesetzblatt, 2002, Teil I Nr. 87, 4623. Prior to the reform a secondary mini-job increased the tax base of the primary job. However, workers with more than two mini-jobs as secondary employment in conjunction with a mini-job as primary employment were subject to income tax and social security contributions on all except two of the mini-jobs.

posed tighter conditions on unemployment benefit recipients. It merged the long-term (i.e. more than 12 months) unemployment assistance benefits with social assistance benefits into *Arbeitslosengeld II* (ALG II) benefits. The level of ALG II benefits is of 345 euros per month in the West, and 331 euros in the East, which is on average lower than the unemployment assistance benefit allowance before the reform.[9] Crucially, ALG II benefits are means-tested at the household level (as before the reform), and the reform affected the eligibility of the long-term unemployed. For example, under Hartz IV benefits can be cut by 30% for 12 weeks if a person who is able to work refuses to enter the activation program or take up a suitable offer of work proposed by the case worker, where Hartz laws explicitly state that about any work is now considered suitable. Repeated refusal leads to further 30% cut for another 12 weeks. Launov and Wälde (2013) estimate that only 24% of the long-term unemployed are able to pass these tests, leaving about three quarters of the long-term unemployed without benefits.

2.2 Data

Our analysis primarily relies on the Sample of Integrated Labour Market Biographies (SIAB) provided by the Institute for Employment Research (IAB). The SIAB is a 2% random sample drawn from the Integrated Employment Biographies (IEB) – an administrative data set which comprises the universe of individuals who are (i) in jobs that are subject to social security (in the data since 1975), (ii) in marginal employment (in the data since 1999), (iii) in benefit receipt according to the German Social Code (since 1975), (iv) officially registered as a job-seeker at the German Federal Employment Agency or (v) participating in active labour market policies (ALMP) programs (in the data since 2000). These data provide information on individuals' daily employment status, education, gender, age, gross daily wage/benefit (wages are top-coded) and a unique identifier that allows us to match the individual's information to that of his/her employing establishment. Since marginal employment has been classified as a separate category since April 1999, we use these data for the period 1999-2014, where 2014 is our last year available.

The German Socio-Economic Panel (GSOEP) is also used to complement the information derived from the SIAB. In contrast to the SIAB the GSOEP data is a household panel survey. The GSOEP started in 1984 and is updated on an annual basis. This data set is used to extract further information on worker demographic characteristics as well as hours worked and hourly wages.[10]

One restriction is made to the sample of workers in our study. Namely, at any point in time workers need to be between 25 and 54 years old. We label this set as prime-aged workers and note that they represent the vast majority (around 65%) of workers in the

[9]Within the ALG II scheme, the state covers the health insurance of the unemployed and until 2010 contributed to their pension scheme. It may also provide for rental costs in case of hardship.

[10]Further information about the SIAB and GSOEP can be found in FDZ (2013) and https://www.diw.de/en/soep, respectively.

German working age population. Younger and older workers are excluded for the following reasons. The 15-24 years old group is excluded to avoid considering individuals who decide to use part-time employment to support their studies, which seems common practice in Germany. The 55-65 years old group is excluded because one objective of the Hartz reforms (and more recent ones) was to increase the participation rate of older workers by affecting their retirement decisions, which seems to have been successful. Even after excluding these two age groups, the labour market dynamics we document for prime-aged workers remain sufficiently intricate.

The registered labour force is defined as the sum of registered employment and registered unemployment. Registered employment consists of the sum of those workers registered in the social security system whose main employment is either a full-time, part-time or a mini- job.[11] Since midi-jobs are taxed, we incorporate them into the contributing part-time employment category. Therefore, we will use the terms mini-jobs and marginal employment interchangeably. Registered unemployment consists of those individuals who are registered with the labour office and have been actively searching for a job within the last 2 weeks irrespectively of their benefit status. We will refer to the registered labour force, employment and unemployment simply as labour force, employment and unemployment. Non-participants are those workers who are not in registered unemployment or in any form of registered employment. This category includes truly inactive individuals, but also non-employed workers enrolled in some ALMP program or self-employed individuals.[12] It is important to highlight that the SIAB does not measure directly non-participation, but it is taken to be the labour market state of workers when they stop being temporarily in the sample. That is, non-participation is a labour market state by default. This feature implies that we cannot distinguish between true non-participants and temporarily discouraged (marginally attached) workers. Nevertheless, below we document large flows between non-participation and unemployment and all forms of employment, suggesting that the dynamics of non-participation is driven by the marginally attached.

Registered unemployment as published by the Federal Employment Agency differs from unemployment calculated from the Labour Force Survey which follows the definition of the International Labour Organisation (ILO), i.e. being without work, being available for work and seeking work. In the European Statistical System, the results of the Labour Force Survey are used as a standard basis for calculating unemployment rates. Registered unemployment is however the most commonly used measure for the analysis of labour market policies (Melis and Lüdeke, 2006). Workers taking part in activation programs are not considered

[11] Using the GSEOP we find that full-time employment involves between 32 and 55 weekly hours, part-time employment involves between 18 and 35 weekly hours and marginal employment involves between 5 and 22 weekly hours. Further, the distribution of weekly hours have been stable during the period of study for full-time and marginal employment, while slighlty increasing for part-time employment. The key feature is that the Hartz reforms do not seem to have meaningfully affected the number of hours worked in these types of employment.

[12] When we use other data sources, such as OECD, GSOEP and EUROSTAT, we follow the same classification definitions.

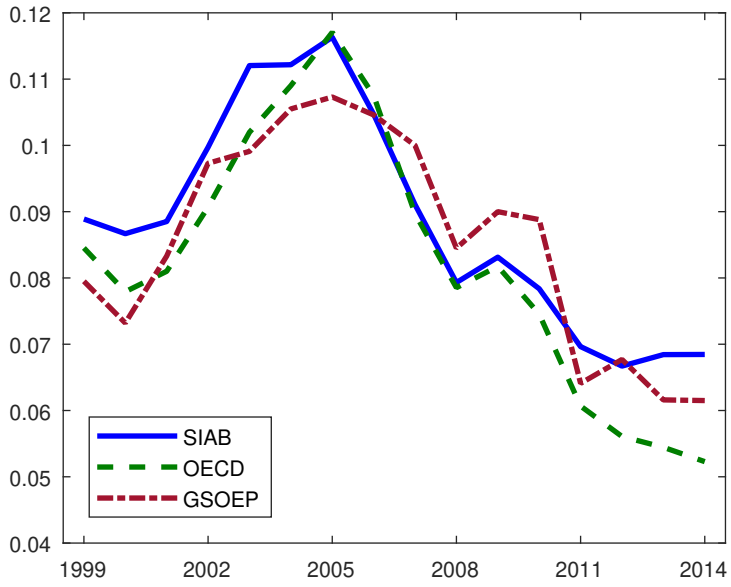


Figure 2: Different unemployment measures

registered-unemployed (see Kruppe et al., 2008, for details). Figure 2 depicts the evolution of the unemployment rate (unemployment stock divided by employment plus unemployment stocks) calculated from SIAB, OECD statistics and GSOEP for the 25-54 age group.[13] The OECD series (the same as the official series from *Statistischen Bundesamt*) is generally below the SIAB series, usually by less than one percentage point, except toward the end of the period where the difference approaches two percentage points. Nevertheless, all series show consistent trends. Unemployment peaks in 2005 and plummets afterwards.

We categorise workers by their type of job contracts. A full-time (part-time) worker is one whose primary employment is in a contributing full-time (part-time) job. An mini-jobber is one whose main employment is a mini-job or one who holds two mini-jobs simultaneously. We refer as part-time workers those who are either contributing part-timers or mini-jobbers.

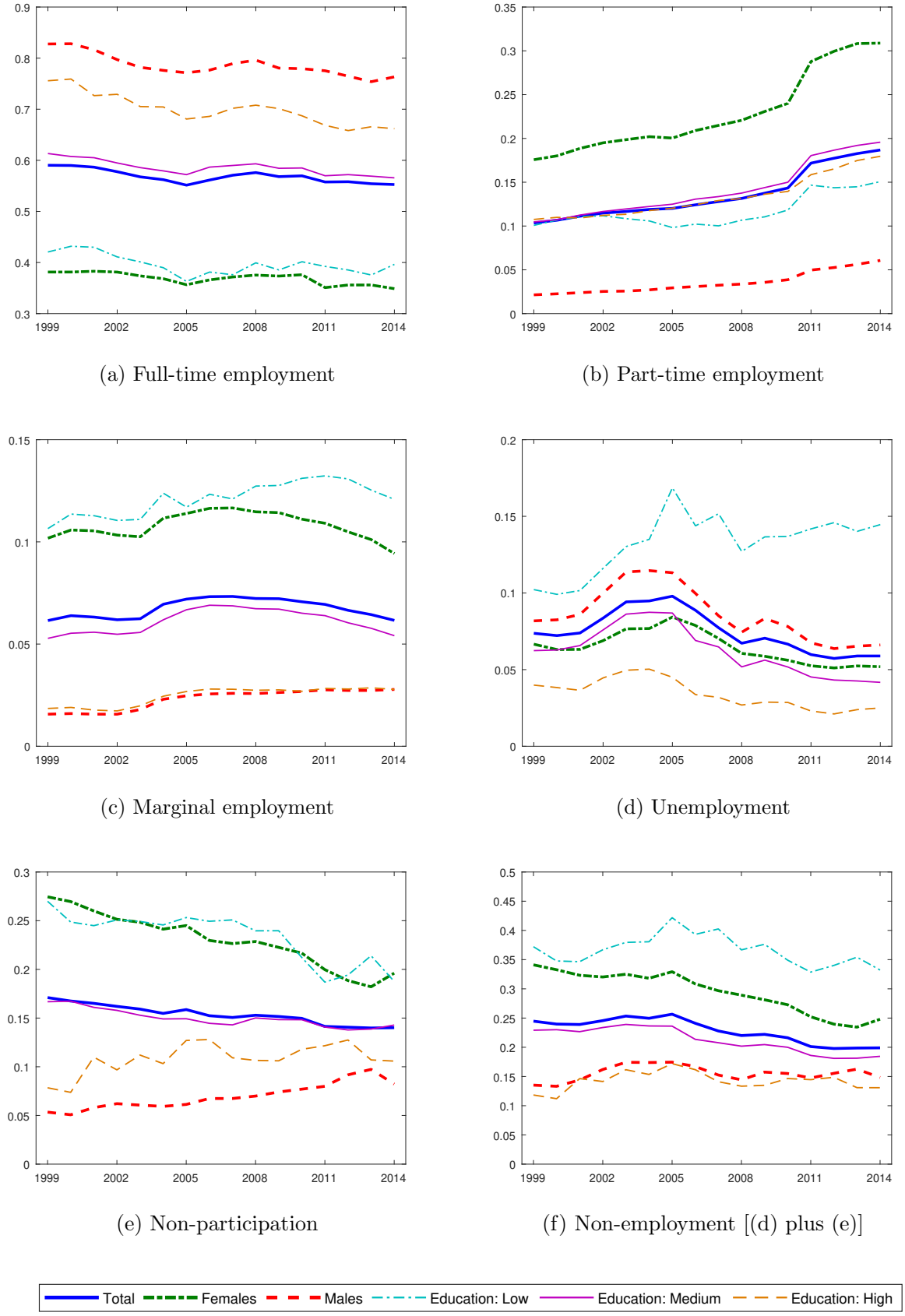
3 The dynamics of stocks

In this section, we document that the increase in the importance of part-time employment occurred together with a reduction of unemployment and non-participation.

Figure 3 depicts the evolution of the stocks of prime-aged workers in full-time employment, part-time employment, exclusive marginal employment, unemployment and non-participation. These stocks are presented as shares of the population of prime-aged individuals, overall and by gender and education.[14] A key feature is the opposing patterns observed

[13]Note that SIAB excludes civil servants (Beamte). Moreover, OECD does not report age-specific self-employment rates (% of self-employed in total employment). We have therefore removed self-employment from the total employment stock under the assumption that self-employment rates are the same in the working age population (18-64) and in the prime age group (25-54).

[14]The SIAB allows us to calculate aggregate stocks of employed and registered-unemployed workers. The



Source: OECD, SIAB and GSOEP. The SIAB data allow to calculate aggregate stocks of employed and registered-unemployed workers. The stocks of non participants are obtained from OECD statistics. The shares of these stocks by gender and education are drawn from the GSOEP.

Figure 3: Dynamics of the labour force and participation (% of the entire prime-aged population)

in the stocks of full-time employment and unemployment relative to the stocks of part-time employment and labour force participation.

Full-time employment decreased from about 60% in 1999 to 55% in 2014, while the share of unemployment decreased from its peak of 10% in 2005 to just below 6% in 2014. In contrast, contributing part-time employment and, to a lesser extent, exclusive marginal employment increased during the 1999-2014 period.[15] Contributing part-time contracts are predominantly signed by female workers, whereas education is not a determining factor. Marginal employment is heavily concentrated among women and low educated workers.[16]

Unemployment is more prevalent among the low educated, but is much less gender differentiated than marginal employment. Note that low educated workers are the only group for which unemployment did not fall after 2005, but remained at a high rate of 15%. Labour force participation increases (slightly) over the period because female and less educated individuals supplied more labour, enough to compensate for the increase of the non-participation of male and higher-educated workers. The last panel displays the non-employment rate, adding up unemployment and non-participation. For men and for high-educated workers the non-employment rate peaks in 2005 but does not fall afterwards, the rise in non-participation compensating one for one the fall in unemployment.

At this stage, two important remarks are in order about measurement. Firstly, since the SIAB counts self-employed workers as non-participants, it is important to note that the increase in the male non-participation rate does not arise because more male workers became self-employed. This might be a concern as Hartz II provided incentives for unemployed workers to become self-employed. Figure 4a shows the stock of non-participants alongside the stock of self-employed individuals by gender obtained from the OECD. It is immediate that among male workers the stock of self-employment is at least one order of magnitude smaller than the stock of non-participants. For females, the difference is even larger. Even though self-employment did increase among male prime-aged workers, this increase was far too small to have a meaningful effect on the dynamics of the stock of male non-participants.

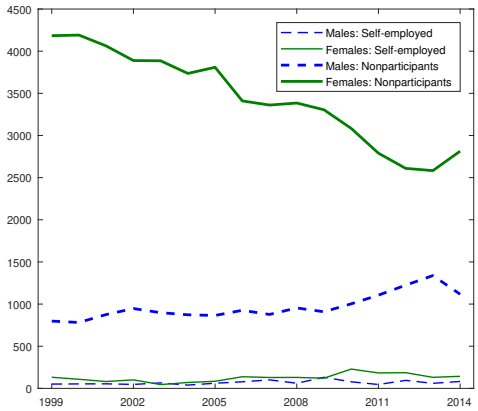
Secondly, the downward trend in full-time employment observed after 2008 in Figure 3a is due to our focus on prime-aged workers. Figure 4b shows the number of full-time workers across all age groups obtained from our sample and from the IAB's official statistics.[17] When aggregating across all age groups, full-time employment did recover in the aftermath of the

stocks of non-participants are obtained from OECD statistics. The shares of these stocks by gender and education are drawn from the GSOEP. The jump in the share of part-time employed in 2011 is related to the improved classification of the part-time versus full-time employment by the Federal Employment Agency. The share of full-time employed went down by the same amount in that year.

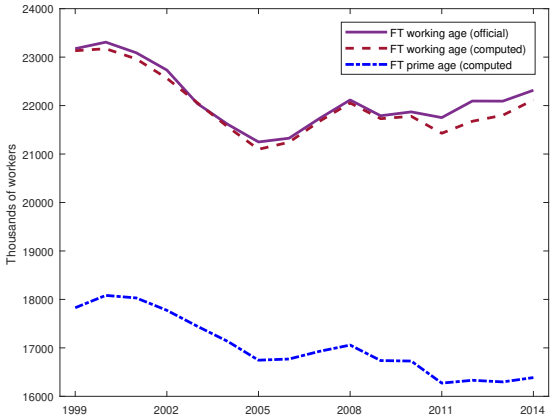
[15] By 2014, there were more workers who had a mini-job as primary employment (7.4% of the labour force) than unemployed workers (6.8% of the labour force).

[16] Low skilled workers are those with no vocational training and no high school degree. Medium skilled workers are those with vocational training (no high school), or high school (no vocational training), or both. High skilled workers are those with a university degree, either from a university of applied science (*Fachhochschule*), technical college (*technische Hochschule*) or a university.

[17] See 'Beschäftigte nach ausgewählten Merkmalen - Deutschland, West/Ost und Länder' at:
https://statistik.arbeitsagentur.de/Navigation/Statistik/Statistik-nach-Themen/Beschaeftigung/Beschaeftigte/Beschaeftigte-Nav.html



(a) The evolution of self-employment relative to non-participation (Source: OECD)



(b) The evolution of aggregate relative to prime-age full-time employment

Figure 4: Dynamics of self-employment and full-time employment

financial crisis; while this did not happen for prime-aged workers. Although not shown here, the main reason for this difference is the recovery of full-time employment among older workers after 2008. The most likely explanation for the latter was the constant policy to incentivise the labour market participation of this older workers after Hartz I. In addition to the employer subsidies introduced by Hartz I, in February 2006 the maximum number of months of unemployment benefits was reduced from 32 to 18 months for those older than 55 (and from 26 to 12 months for those under 55); and between the 2006-2010 period there was a progressive phasing-out of early retirement options to encourage older persons to continue working. Indeed, we find that the number of older workers dramatically increased after 2003 and followed an upward trend in the period after the Hartz reforms.

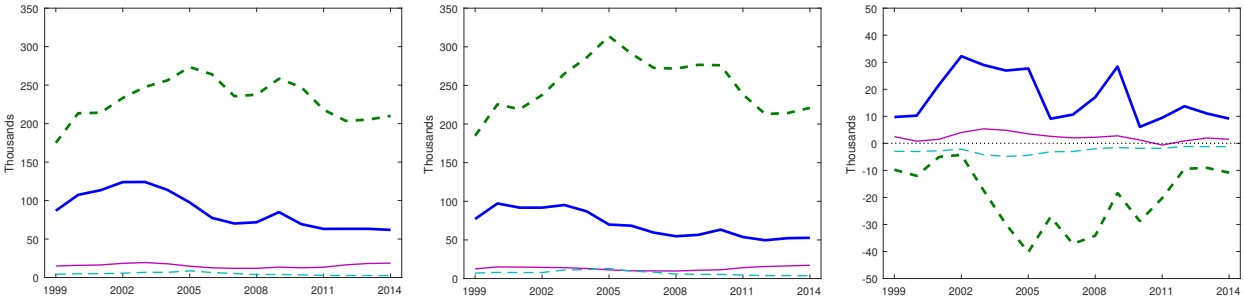
4 The dynamics of flows

An important contribution of this paper is to explain the evolution of the stocks reported in Section 3, highlighting the role of part-time employment. For this purpose we use the SIAB to construct the gross and net flows of each of these employment categories and investigate the dynamic system underlying the stocks. We then derive the stationary distribution of the stocks implied by the flows and proceed to various counterfactual simulations to determine which flows can best explain the observed stocks depicted in Figure 3. For this analysis we focus on aggregate and gender specific flows, as the only other demographic variable in the SIAB is education and the pool of unemployed is mostly composed by low educated workers.

4.1 The ins and outs of unemployment

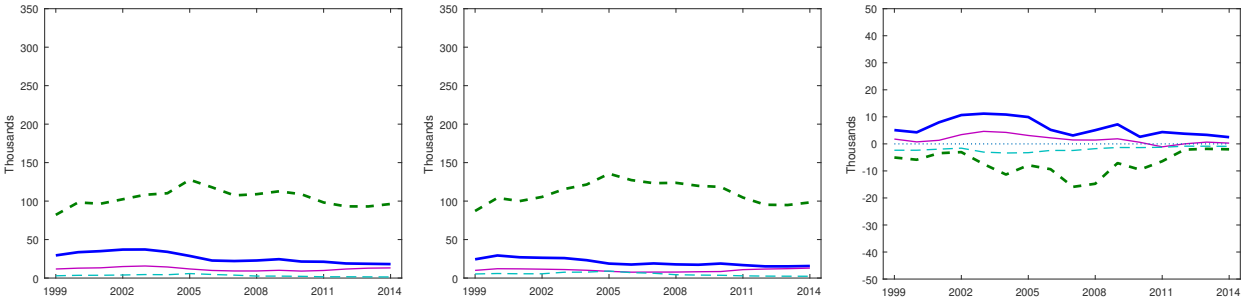
Figure 5 depicts the average monthly inflows to unemployment, outflows from unemployment and the net inflows (inflow minus outflow), measured in thousands of workers. These flows

All



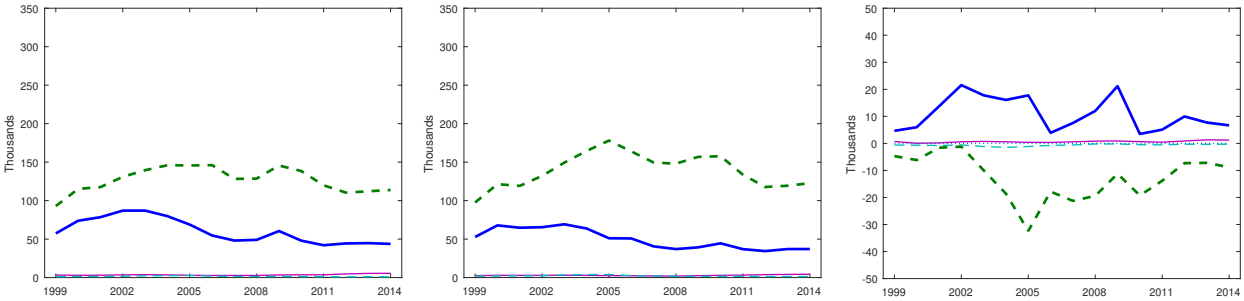
(a) Inflows (b) Outflows (c) Net: Inflows - Outflows

Females



(d) Inflows (e) Outflows (f) Net: Inflows - Outflows

Males



(g) Inflows (h) Outflows (i) Net: Inflows - Outflows

Figure 5: Unemployment flows

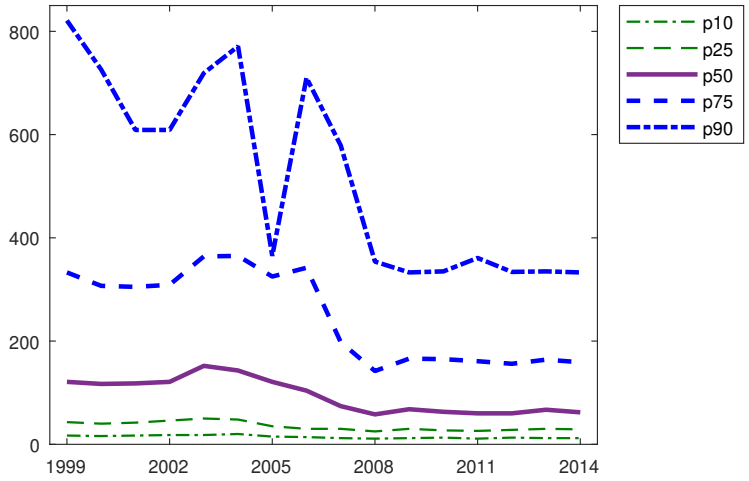


Figure 6: Elapsed duration of unemployment at the end each year (in days; excludes fixed-term contracts. Source SIAB)

are decomposed by the worker's origin and destination states: full-time employment (FT), contributing part-time employment (PT), exclusive marginal employment (ME) and non-participation (NP). We show the flows for the whole population (first row) and separately by gender (second and third rows).

Looking first at gross flows, we see that by far the two main sources and destinations of unemployment are non-participation and full-time employment. That so many individuals churn between unemployment and non-participation indicates that a large fraction of individuals who are not registered at the German Federal Employment Agency are counted as non-participants, yet have not, or only temporarily, stopped searching for a job. Gross flows between unemployment and non-participation are of similar magnitude for men and women. Flows with full-time employment are lower for female workers and flows with part-time employment are bigger.

Net flows show a striking feature. The main reason behind the reduction in German unemployment was not re-employment in a contributing job (either full-time or part-time) or in a marginal job. Instead the unemployment rate decreased because individuals stopped registering as unemployed and became non-participants. About 19,000 more workers went from unemployment into non-participation each month than from non-participation into unemployment. These net outflows peaked in 2005 at about 37,000 workers and exhibited a gradual decline thereafter. This contrasts with the flows associated with full-time employment. Every month more full-time workers entered unemployment than unemployed obtained a full-time job. These monthly net inflows were of about 17,000 workers, although peaking at 32,000 earlier in 2002.

We also see that part-time employment, including marginal employment (mini-jobs) essentially concerns female workers. Figure 5 shows that more unemployed workers took a mini-job than there were mini-jobbers becoming unemployed. Every month there were around 7,000 individuals leaving unemployment to take up a mini-job, while there were around

4,500 mini-jobbers becoming unemployed.[18] At the same time, every month there were on average around 15,000 workers (mostly female) leaving a contributing part-time job to enter unemployment and on average around 13,000 individuals leaving unemployment to take a contributing part-time job. Pooling together marginal employment and contributing part-time employment, this implies that on average nearly the same amount of workers entered unemployment from the part-time employment sector as there were individuals leaving unemployment to take part-time jobs. Contrary to non-participation, this evidence shows that the effectiveness of part-time employment in *directly* reducing unemployment was negligible.

Although not shown here we find that for medium and high skilled workers unemployment decreases because of the larger net outflows into non-participation. In the case of low skilled workers, however, unemployment continued increasing after 2005 because the net inflows from contributing employment balanced in most years the net outflows into non-participation and marginal employment. Since the vast majority of prime-aged workers in our data have a vocational training (but no high school), the behaviour of low skilled workers does not affect much the aggregate dynamics depicted in Figure 5.

Figure 6 shows the evolution of the distribution of elapsed unemployment duration in stock samples on the last day of each year. It shows that accompanying the reduction in the stock of unemployed workers was a striking collapse of the right tail of the unemployment duration distribution. During the 2007-2014 period, the median duration of an unemployment spell was essentially half of that observed during the 1999-2004 period.[19] Stronger reductions can also be observed at the 75th and 90th percentiles of the duration distribution. This confirms that the reduction in unemployment after 2005 was obtained by limiting long-term unemployment. The most likely reason for this conversion is Hartz IV, which cut unemployment benefits and reformed the welfare system.

4.2 The ins and outs of non-participation

Given that unemployment decreased because individuals became non-participants, we now investigate whether non-participation acted as a transitional step towards employment.

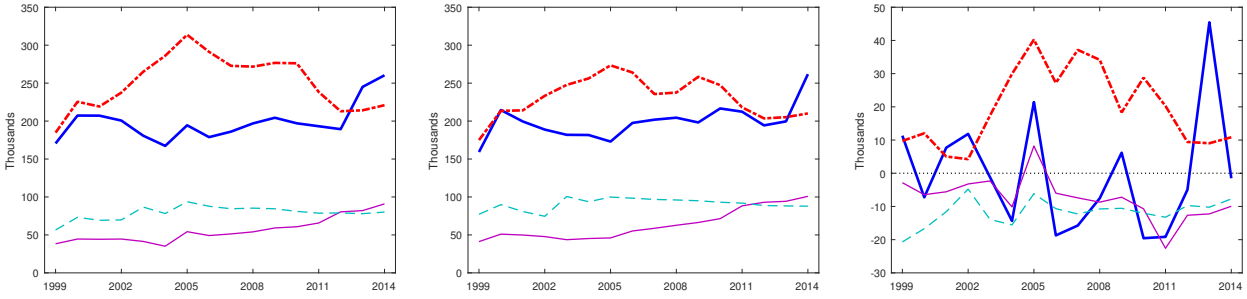
Figure 7 shows the evolution of the average monthly flows into and out of non-participation. The most striking feature is that these flows are huge, indicating again that non-participation should be understood as non-registered unemployment or long-term unemployment. In particular, flows with unemployment and flows with full-time employment are of similar magnitude.

Second, we already know that non-participation increases over time for prime-aged men.

[18]The outflows from unemployment to exclusive marginal employment also reflect that many individuals (on average 71.3% of the outflow from unemployment to marginal employment) remained unemployed but topped up their unemployment benefits with the earnings from a mini-job.

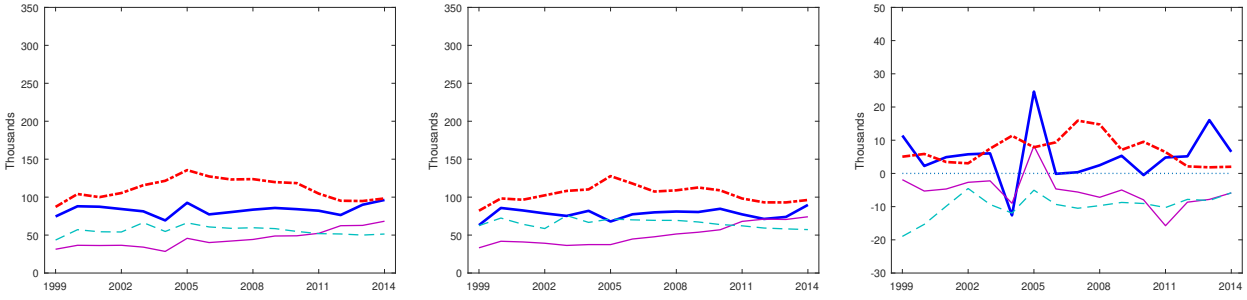
[19]The collapse of the right tail in 2005 and its rebound in 2006 occurred because Hartz IV abolished social assistance, so all former recipients of social assistance had to register as unemployed on the 1st January 2005, partly explaining the rise in unemployment during 2005. This resulted in a 16% mass point in the distribution of the elapsed duration at the end of 2005. At the end of 2006 the mass point has reduced to 4.5%. In 2007 it became negligible.

All



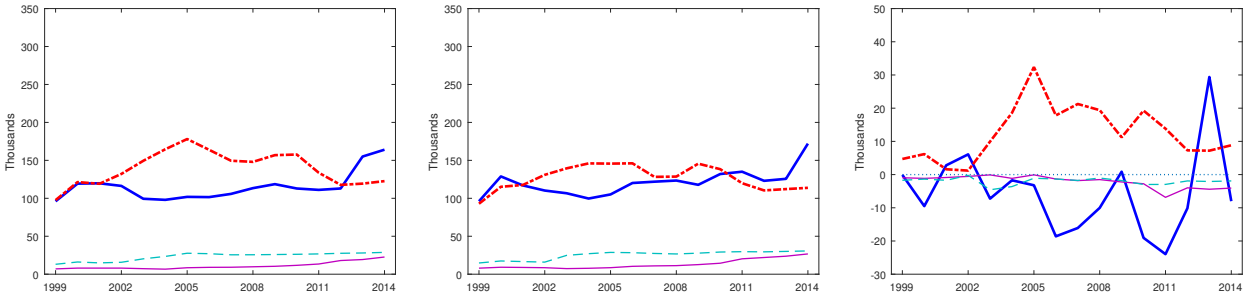
(a) Inflows (b) Outflows (c) Net: Inflows - Outflows

Females



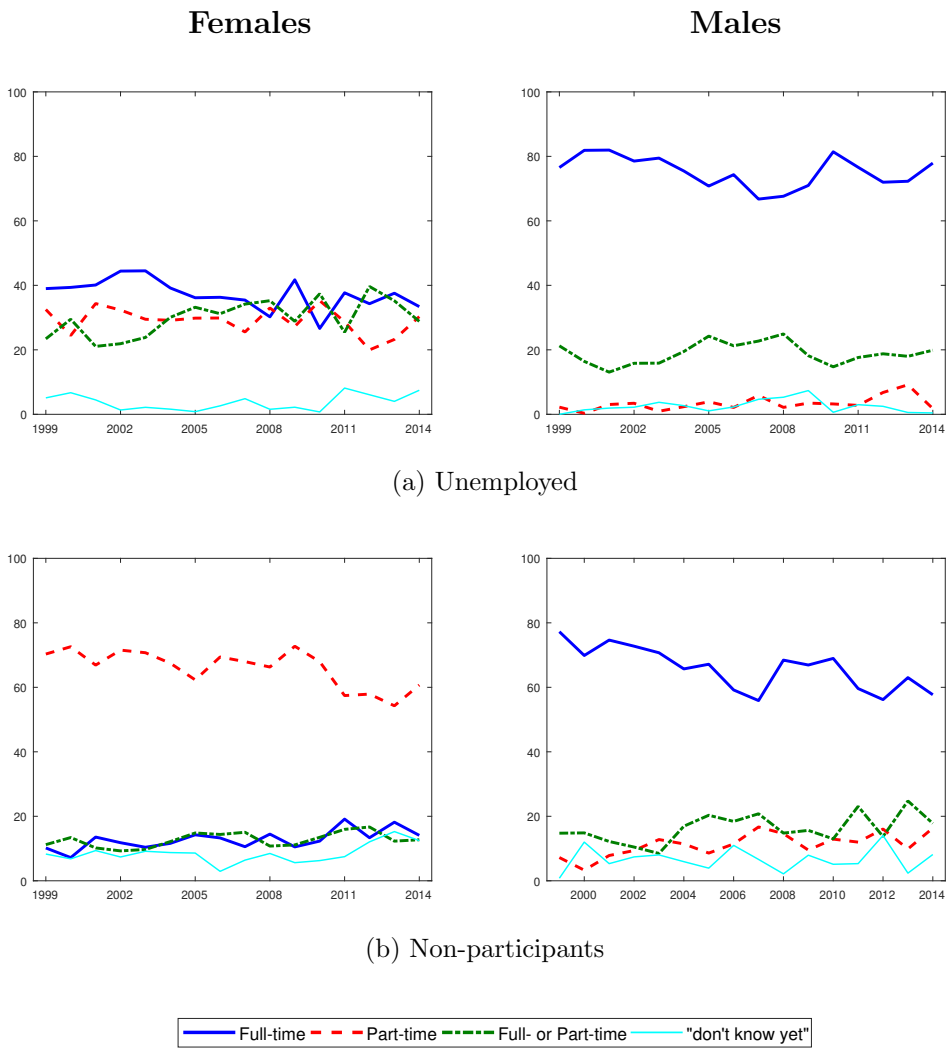
(d) Inflows (e) Outflows (f) Net: Inflows - Outflows

Male



(g) Inflows (h) Outflows (i) Net: Inflows - Outflows

Figure 7: Flows into and from non-participation



(a) Unemployed

(b) Non-participants

Figure 8: Desired employment for unemployed and non-participants in % (Source: GSOEP)

The flow analysis shows that this is because transitions to full-time employment do not compensate the entries from unemployment. For male workers, transitions from and to part-time employment are too small to make a difference. For women, we observe a lot more transitions with part-time work (contributing and marginal roughly in equal proportions). These are the ones which work against the transitions from unemployment.

Overall these patterns present clear macroeconomic evidence that part-time employment, and mini-jobs in particular, helped bring female non-participants to work, fuelling the rise of part-time employment in Germany and containing the net inflows from unemployment into non-participation.

The GSOEP asks unemployed workers and non-participants what type of employment they are looking for or would be looking for. Figure 8 shows the answers by gender. For men, being unemployed or non-participant does not change their answer. They primarily search for a full-time job. For women, this is different. Non-participants do favour part-time over full-time work. Note that over time, male non-participants look at part-time work a bit more positively and female non-participants a bit more negatively.

4.3 The ins and outs of exclusive marginal employment

Given the importance of marginal employment in bringing female non-participants back to work, we now investigate whether mini-jobs acted as stepping stones towards contributing employment or represented dead-end jobs. For this purpose, Figure 9 shows the gross flows of exclusive marginal employment, as well as its net inflows (inflows minus outflows). It shows that the main source and destination of exclusive marginal employment is by far non-participation. Every month after 2000, on average about 90,000 individuals left non-participation to take a mini-job, and about 80,000 mini-jobbers returned to non-participation. These flows are maximum in 2005-2006. Further, non-participation was also the main source of the net inflows into exclusive marginal employment, around five times larger than the average net inflows from unemployment (recall that the marginal employed are not entitled to unemployment benefits).

Figure 9c then shows that all the net outflows from exclusive marginal employment went to contributing employment (full-time and part-time). We find that on average about 12,000 more workers with a mini-job left for a contributing contract every month than the other way around.[20] Second, the net outflows from marginal employment into contributing employment are of a similar order of magnitude as the net inflows from non-employment (non-participation and unemployment). This explains the lack of growth in the stocks of exclusive marginal employment documented in Figure 3. Lastly, after 2007, contributing part-time employment became the main destination of marginally employed workers. Although not shown here, we also find that around 40% of those mini-jobbers who found a contributing job retained their mini-job to benefit from the tax exemptions introduced by Hartz II.

These net outflows are comprised primarily of female workers (in proportion 3:1) with either no qualifications (low skilled) or just a vocational/high school qualification (medium skilled). Mini-jobbers churn between non-participation and marginal employment. Yet, a significant fraction of female exclusive mini-jobbers are able to find a contributing job, more frequently part-time. This is, we believe, a clear evidence that mini-jobs acted as stepping stones to contributing employment, but this is true only for women.

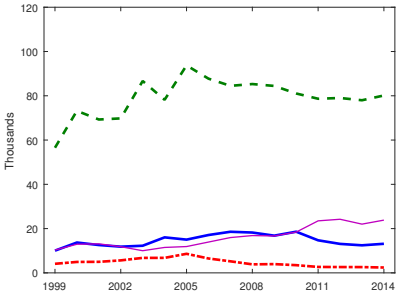
4.4 The ins and outs of contributing part-time employment

The evidence in Section 4.2 showed that the second most important destination of the net outflows from non-participation was to contributing part-time employment. Figure 10 shows the gross and net flows of this category. Although the share of part-time labour increases over time for men, all forms of part-time work are predominantly occupied by women. It is therefore not surprising that, as in the case of the marginal employment flows, part-time

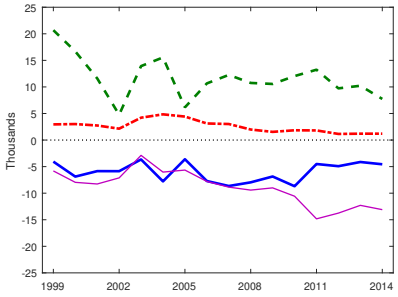
[20]Note that Hartz II changed the maximal earnings limit to qualify for a mini-job from 325 to 400 euros. This may have encouraged the conversion of contributing jobs into mini-jobs to take advantage of the tax break. However, if there is a one-off increase in the inflows from contributing employment in 2003, it is small.

All

(a) Inflows

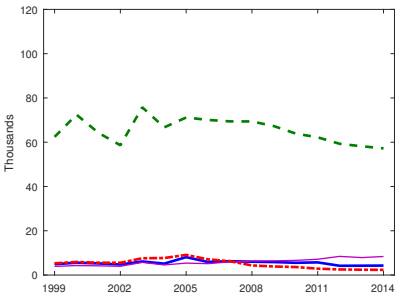


(b) Outflows

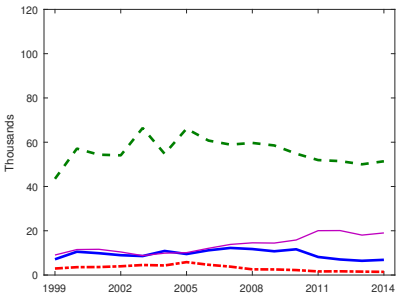


(c) Net: Inflows - Outflows

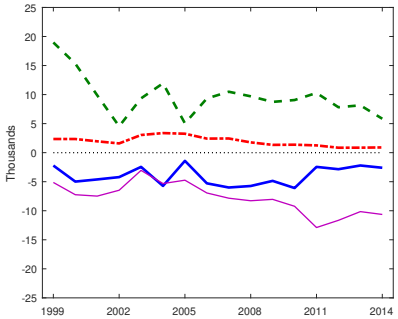
Females



(d) Inflows

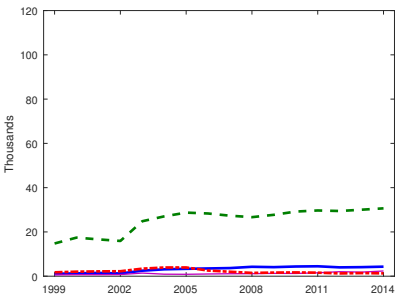


(e) Outflows

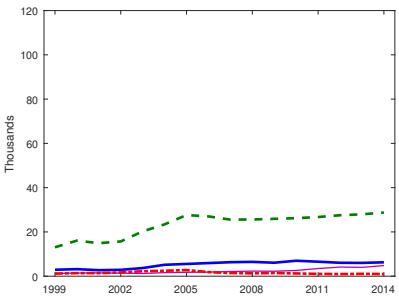


(f) Net: Inflows - Outflows

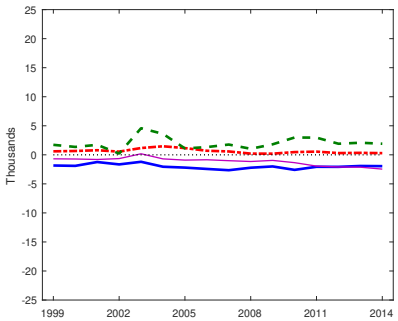
Males



(g) Inflows



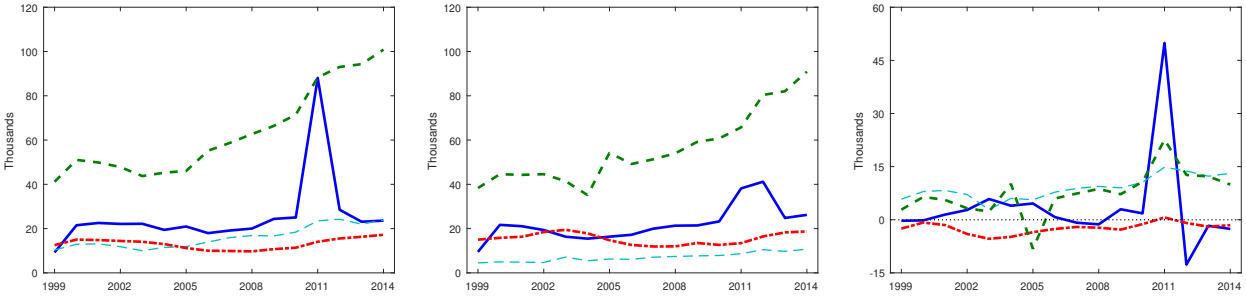
(h) Outflows



(i) Net: Inflows - Outflows

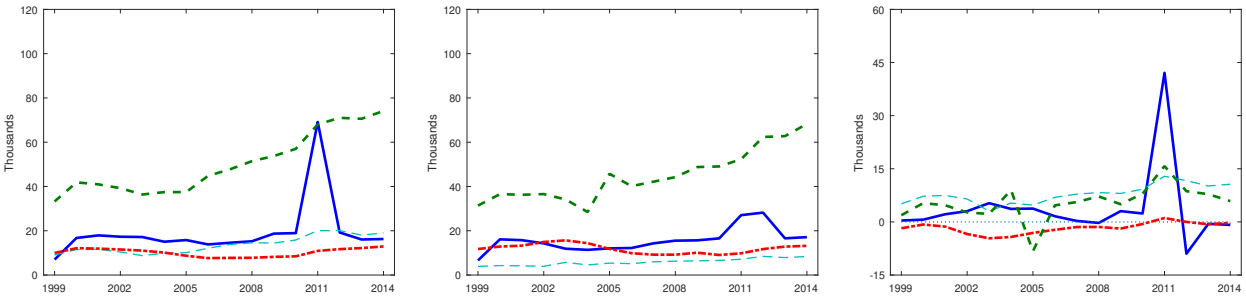
Figure 9: Flows into and from marginal employment

All



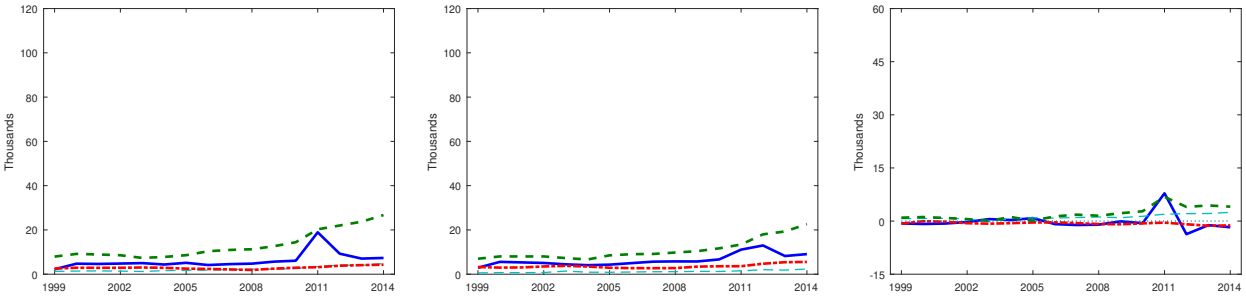
(a) Inflows (b) Outflows (c) Net: Inflows - Outflows

Females



(d) Inflows (e) Outflows (f) Net: Inflows - Outflows

Males



(g) Inflows (h) Outflows (i) Net: Inflows - Outflows

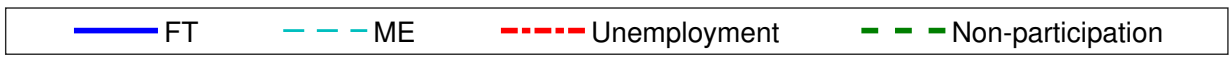


Figure 10: Flows into and from contributing part-time employment

flows are mostly comprised of medium skilled, female workers.

As in the case of marginal employment, we also observe that the main inflows and outflows of contributing part-time employment are with non-participation. The difference is that the gross flows between non-participation and contributing part-time employment started increasing after 2005, while the gross flows between non-participation and exclusive marginal employment exhibited a decreasing trend after 2005. This has led the gross flows between non-participation and contributing part-time employment and the gross flows between non-participation and exclusive marginal employment to become of similar magnitudes after 2010.

The net inflows in Figure 10 show that the stock of contributing part-time employment increased over the period because of the strong net inflows from marginal employment and non-participation, and to a lesser extent from full-time employment (except for the spike in 2011 due to a change in the definition of part-time work in the SIAB). This evidence highlights another important feature in the German labour market dynamics: Mini-jobs were an important driving force behind the growth of contributing part-time employment.

4.5 The ins and outs of full-time employment

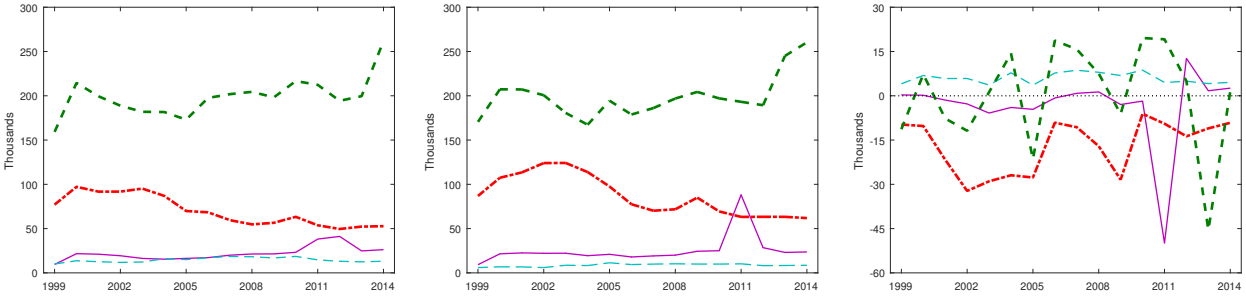
To complete the dynamic system described until now, Figure 11 depicts the average monthly gross and net flows of full-time employment. From these graphs it is clear that the main gross flows of full-time employment arise from non-participation and from unemployment. Consistent with the decrease in unemployment shown in previous sections, we observe that both the inflows and outflows between full-time employment and unemployment started to decrease during the implementation period of the Hartz reforms. By 2014 these gross flows decreased to about half of the size they had in 2003. In contrast, the inflows and outflows between full-time employment and non-participation remained overall constant around 200,000 workers, with a slight decrease up to 2004/2005 and a slow rebound after that.

The picture presented by net flows is very different for men and women. For women, the only positive contribution to the stock of full-time jobs is marginal employment. Unemployment, non-participation and contributing part-time employment all contribute negatively. Overall, the negative net flows dominate the positive ones, which leads to a reduction in female full-time employment. For men, all net flows are negligible but with non-participation and unemployment. The stock of full-time, male workers is fattened up by non-participants and thinned down by unemployment.

5 Counterfactual analysis of labour stocks

In this section, we seek to evaluate which flows are the main drivers of the observed dynamics of the stocks.

All

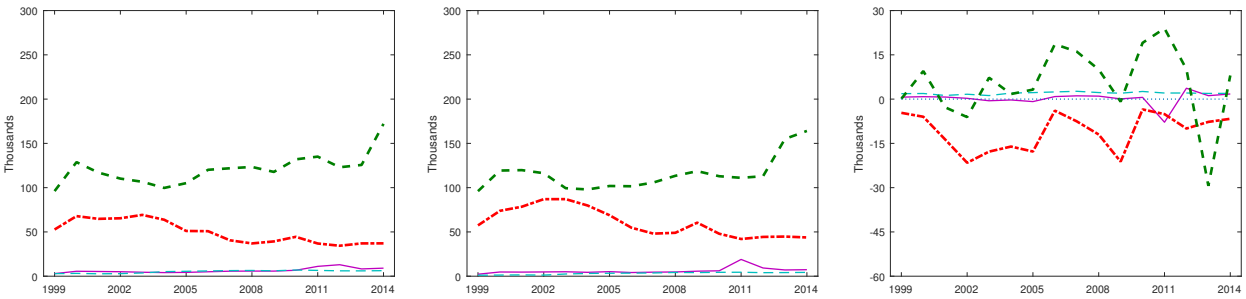


(a) Inflows (b) Outflows (c) Net: Inflows - Outflows

Females

(d) Inflows (e) Outflows (f) Net: Inflows - Outflows

Males



(g) Inflows (h) Outflows (i) Net: Inflows - Outflows

Figure 11: Flows into and from contributing full-time employment

5.1 How well do flows determine the evolution of the stocks?

We first investigate how well the gross yearly flows and associated net flows predict the observed stock of workers in each of the labour market states considered. In particular, are one-period ahead flows the main determinants of the stocks? Are we missing important channels requiring two lags for example? Two prominent features of the dynamics that we have just described are (i) that there are very large flows into and from the different stocks, and (ii) that inflows and outflows are of similar size, so that the net flows are generally an order of magnitude smaller. This implies that one can approximate the observed stocks quite well by the stationary distributions associated with the transition probability matrices estimated from the flows.

Figure 12 presents the evolution of the stationary distribution of workers across the states of the labour market. This distribution is constructed on the basis of the estimated sequence of monthly transition matrices across all the market states for every year. The procedure is as follows. For any two adjacent months within a given year we consider the change in the stocks sampled at the last date of each month. The change in the stock of individuals in any given state is defined as the sum of the inflows from all other states less the sum of the outflows to all other states within the corresponding month. Hence, each row of the monthly transition matrix is estimated as the number of outflows from a given source state to any destination state (including staying in the current state). Summing over all months within a year and dividing by the total number of outflows from this source state over all months within a year gives us the non-parametric estimate of the transition matrix expressed in terms of monthly transition probabilities.[21] We then calculate the corresponding stationary distribution of the labour market states. This stationary distribution is the normalised left eigenvector associated to the eigenvalue 1 of the estimated transition probability matrix.

This procedure can be simply illustrated with only two states, employment and unemployment. The law of motion for unemployment is $u_t - u_{t-1} = s_t(1 - u_t) - f_t u_t$, where s_t is the separation rate and f_t the job finding rate. This accounting equation says that in order to calculate the unemployment stock at time t, u_t, one needs to know the flow rates f_t and s_t, but also the base stock u_{t-1}. However, if the net flow $\dot{u}_t = u_t - u_{t-1}$ is small compared compared to the gross inflow $s_t(1 - u_t)$ and the gross outflow $f_t u_t$, then it approximately holds that $u_t \approx s_t/(s_t + f_t)$.

The proportions based on flow data fluctuate slightly more (despite the yearly averaging of monthly rates) but yet follow very closely the observed stocks in all labour market states. A key implication from this exercise is that in Germany any policy that affects the monthly flows very soon shows up in the stocks. We believe this is remarkable given the common view that the German labour market is not as fluid in terms of worker flows and its employment

[21] The SIAB does not measure the stocks of non-participants, but at the same time allows us to determine the outflows from non-participation to any other state and inflows from any other state to non-participation quite precisely. Consequently, only the number of stayers in non-participation between any two adjacent months is missing. We estimate this number using OECD aggregate statistics on non-participation. The Data Appendix gives detailed account of how this is done.

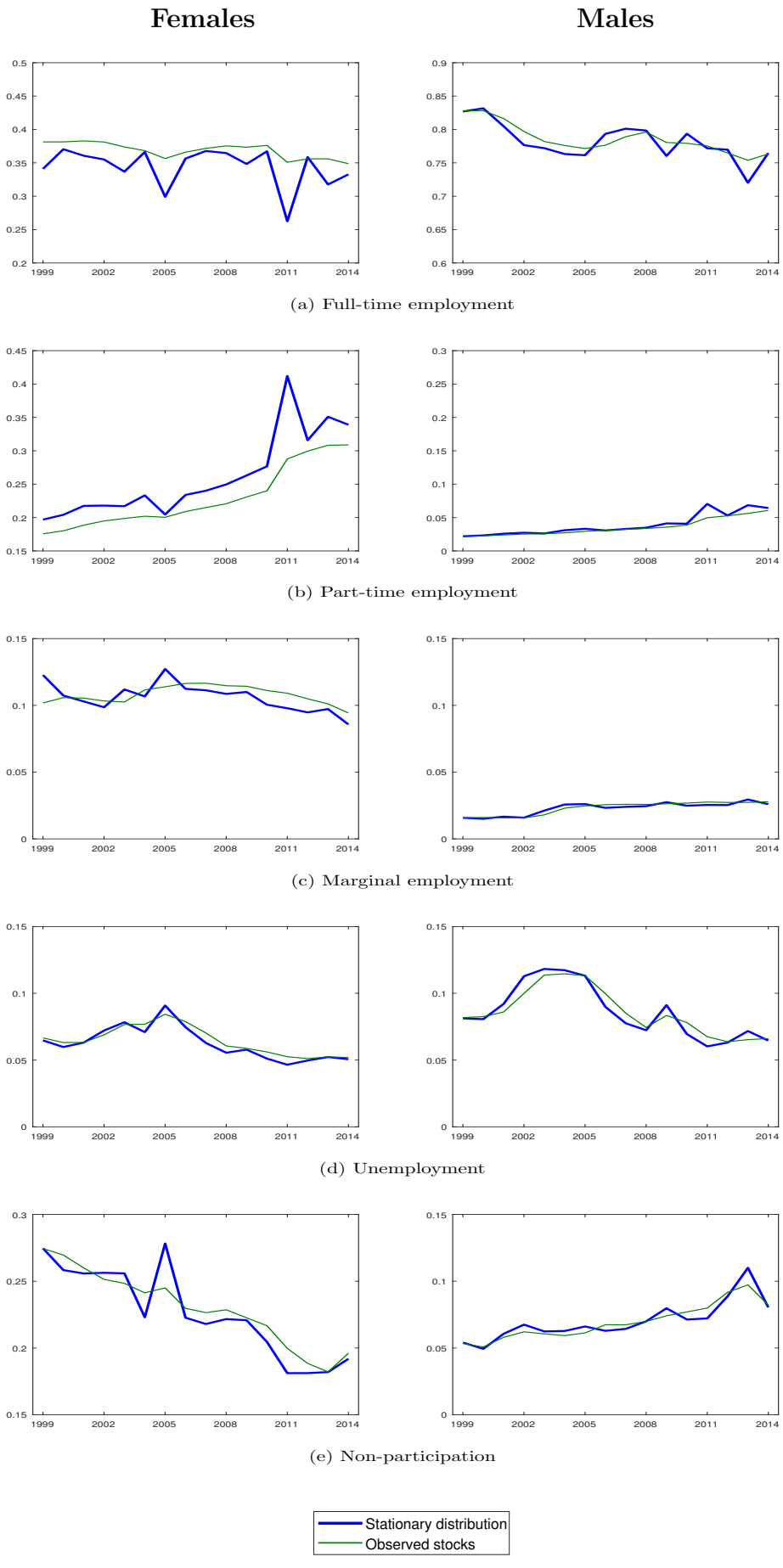


Figure 12: Stationary distribution of labour market states

protection legislation is stricter relative to Anglo-Saxon labour markets.

5.2 Counterfactual simulations

Now that we have demonstrated the ability of the flows to predict the stocks, we can move on to determine which flows are the main drivers of the observed dynamics of the stocks.

Our starting point is the estimated transition probability matrix for 2002, just before the start of the Hartz reforms. Each row of this matrix contains the transition probabilities from one particular state, say unemployment. We then conduct counterfactual simulations that apply all observed changes to transitions from one particular state in all years after 2002, but keep constant the other transition probabilities to their 2002 value. Figures 13-17 depict the evolution of the stocks predicted by our counterfactual exercise, and compare it to the actual ones.

Figure 13 shows the changes in all stocks that would have been observed had the transition probabilities from unemployment (i.e. outflow probabilities) changed as observed after 2002. As suggested from the flow analysis in Section 4.1, these probabilities obviously do little to explain the observed changes in the different forms of employment (full-time, contributing part-time or marginal). For both men and women, unemployment is reduced and non-participation is increased in equal proportions. For women, this mechanism suffices to explain most of the reduction in unemployment soon after 2002, but progressively loses power, to only explain $\frac{0.060-0.072}{0.051-0.072} = 56\%$ of the reduction when comparing 2002 to 2014. For males, unemployment outflows have even less traction on the change in unemployment. They only explain $\frac{0.101-0.113}{0.065-0.113} = 25\%$ of the reduction in male unemployment, when comparing 2002 to 2014. This suggests that the stringent conditions imposed by the Hartz reforms on unemployed workers seem unable to explain, on their own, the large reduction in unemployment by way of outflows.

Figure 14 considers only changes to transitions from non-participation to all other states. This counterfactual does very well in capturing the observed changes in the different forms of employment and non-participation. It picks up the increase in part-time work (contributing and marginal) as well as the strong decrease in female non-participation and the more moderate increase in male non-participation. The outflows from non-participation do nothing to explain female unemployment. In contrast non-participation outflows do explain part of the reduction in male unemployment. This last point was not totally obvious from the flow analysis of the previous section. Over time, there are fewer transitions of male prime-aged workers from non-participation to any other states, which increases the stock of non-participants. There are also fewer transitions to unemployment (a non-registered unemployed would register again) and to full-time jobs, which decreases the corresponding stocks, but more transitions from non-participation to part-time jobs.

Figure 15 shows the simulations results obtained using transition outflow probabilities from *both* unemployment and non-participation. The key characteristic of this exercise is that it captures the net flows between unemployment and non-participation depicted in Figures

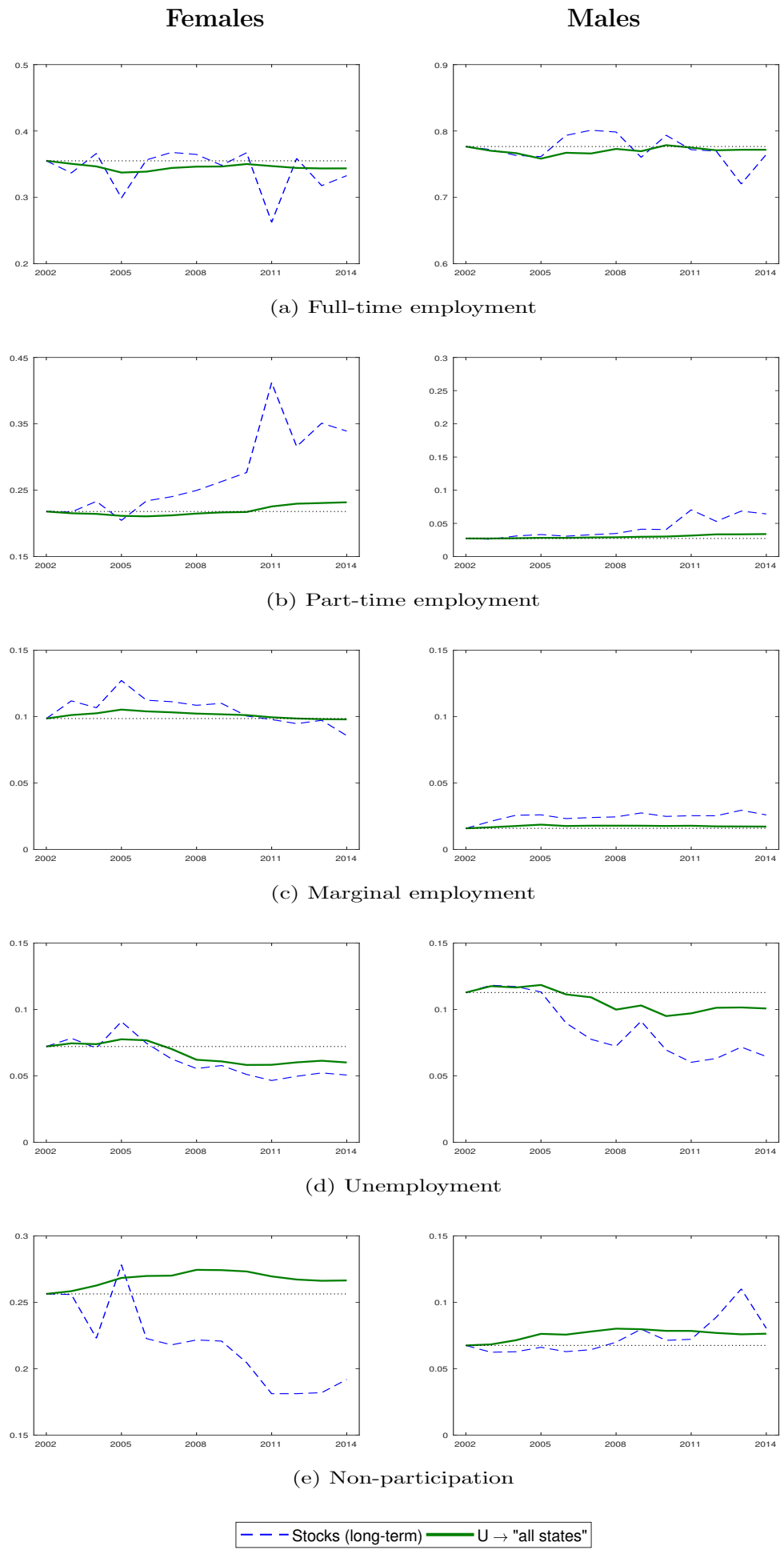


Figure 13: Counterfactual simulations where only transitions from unemployment change

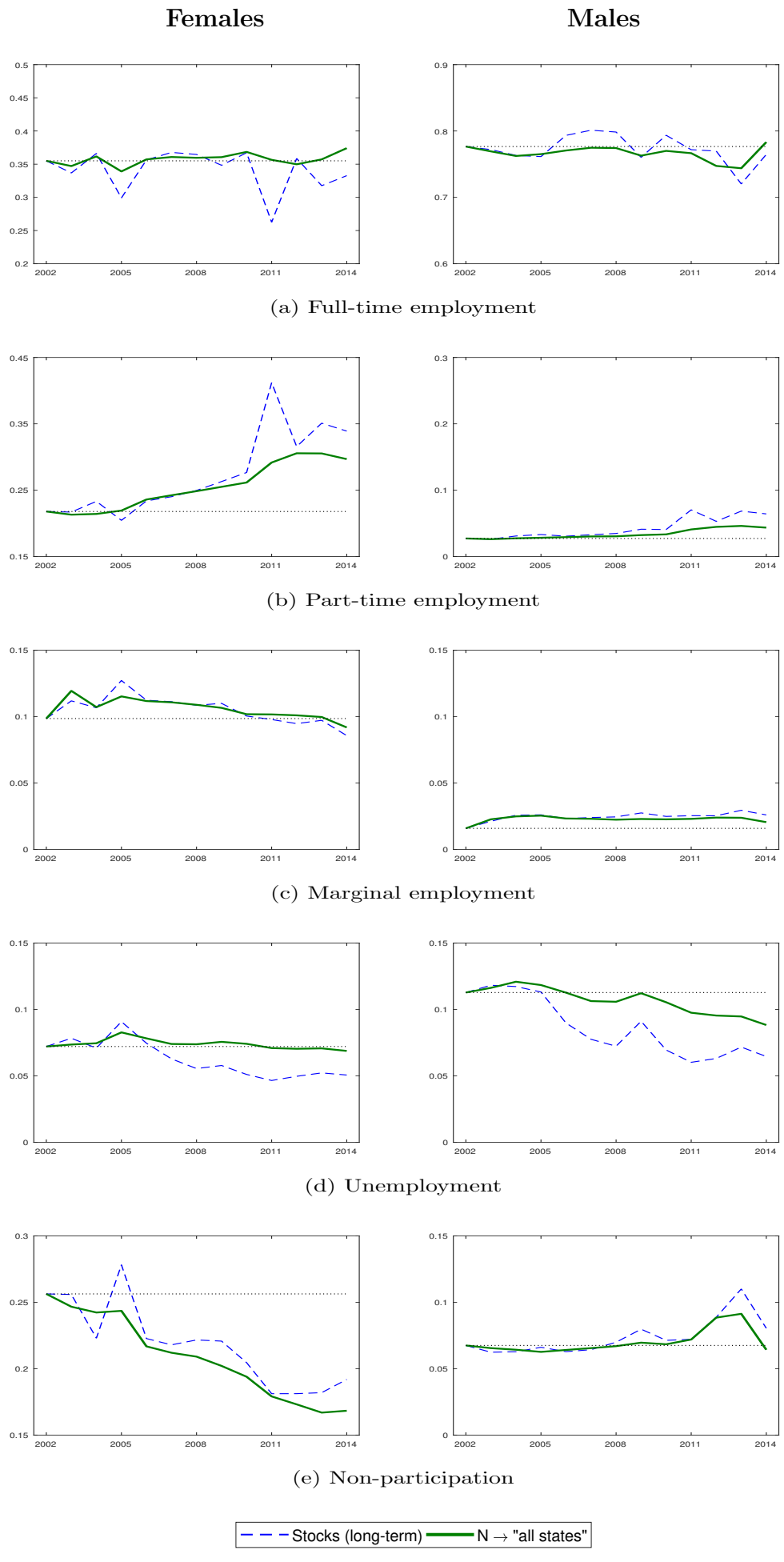


Figure 14: Counterfactual simulations where only transitions from non-participation change

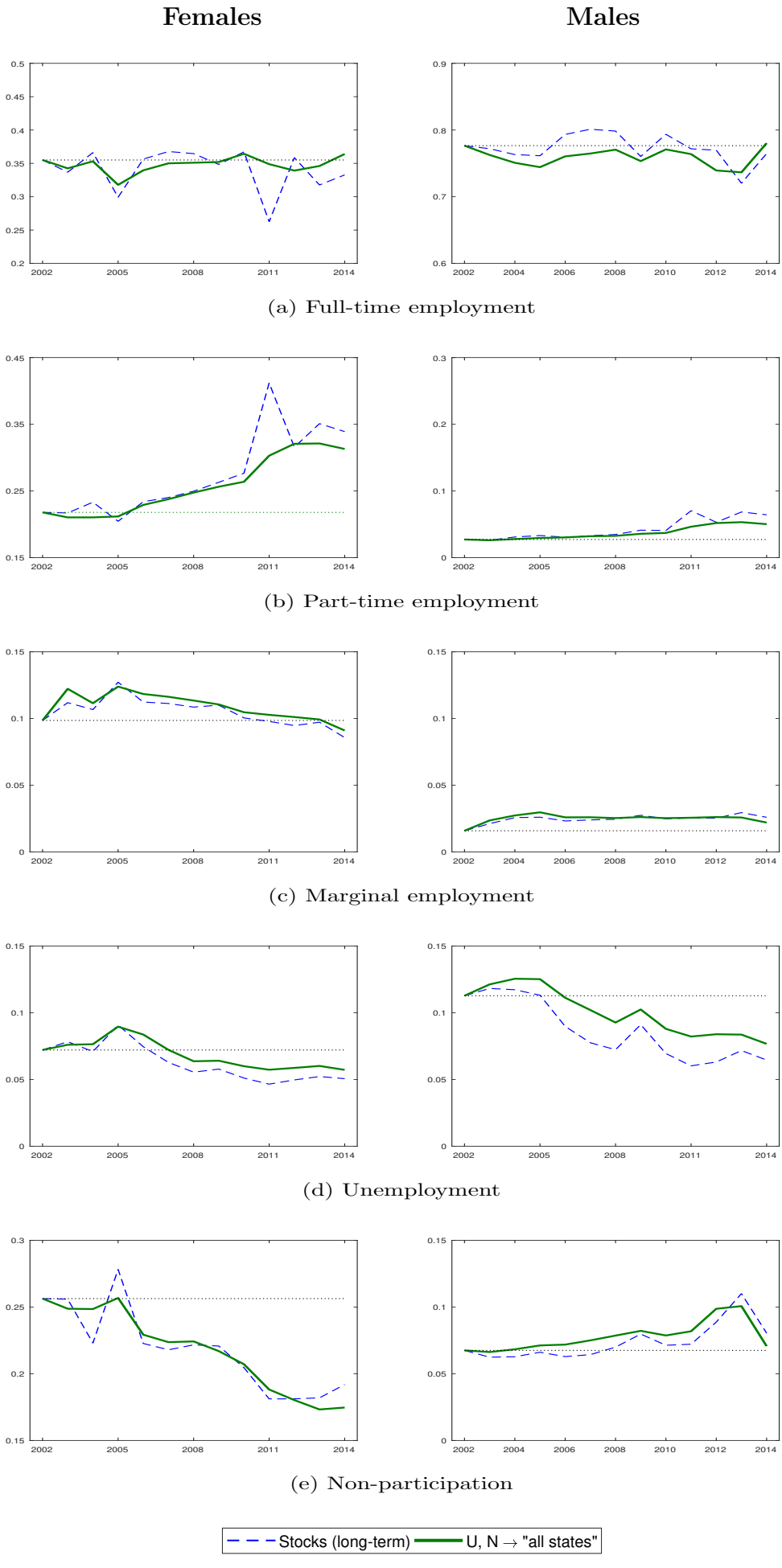


Figure 15: Counterfactual simulations where only transitions from unemployment and non-participation change

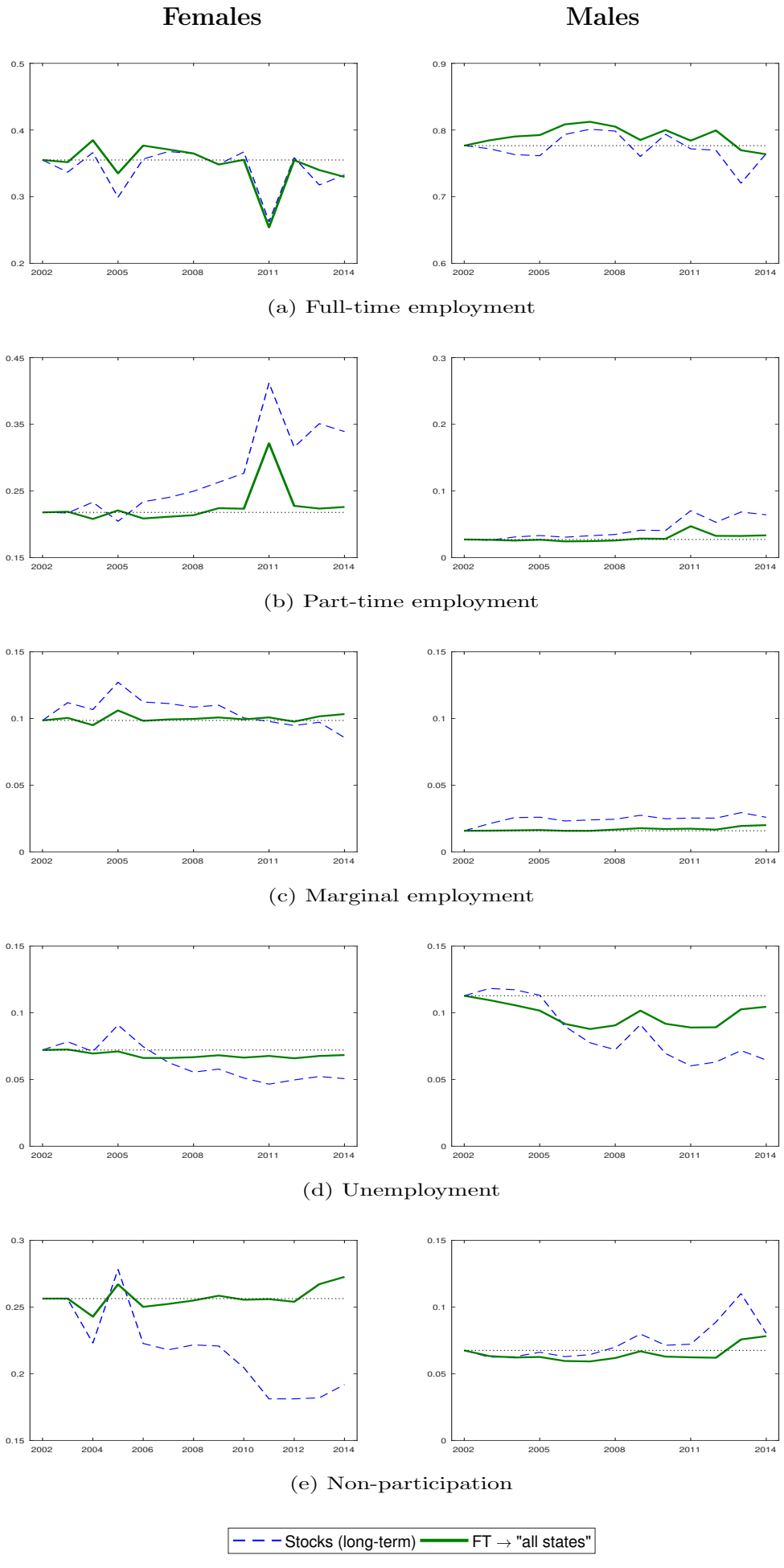


Figure 16: Counterfactual simulations where only transitions from full-time employment change

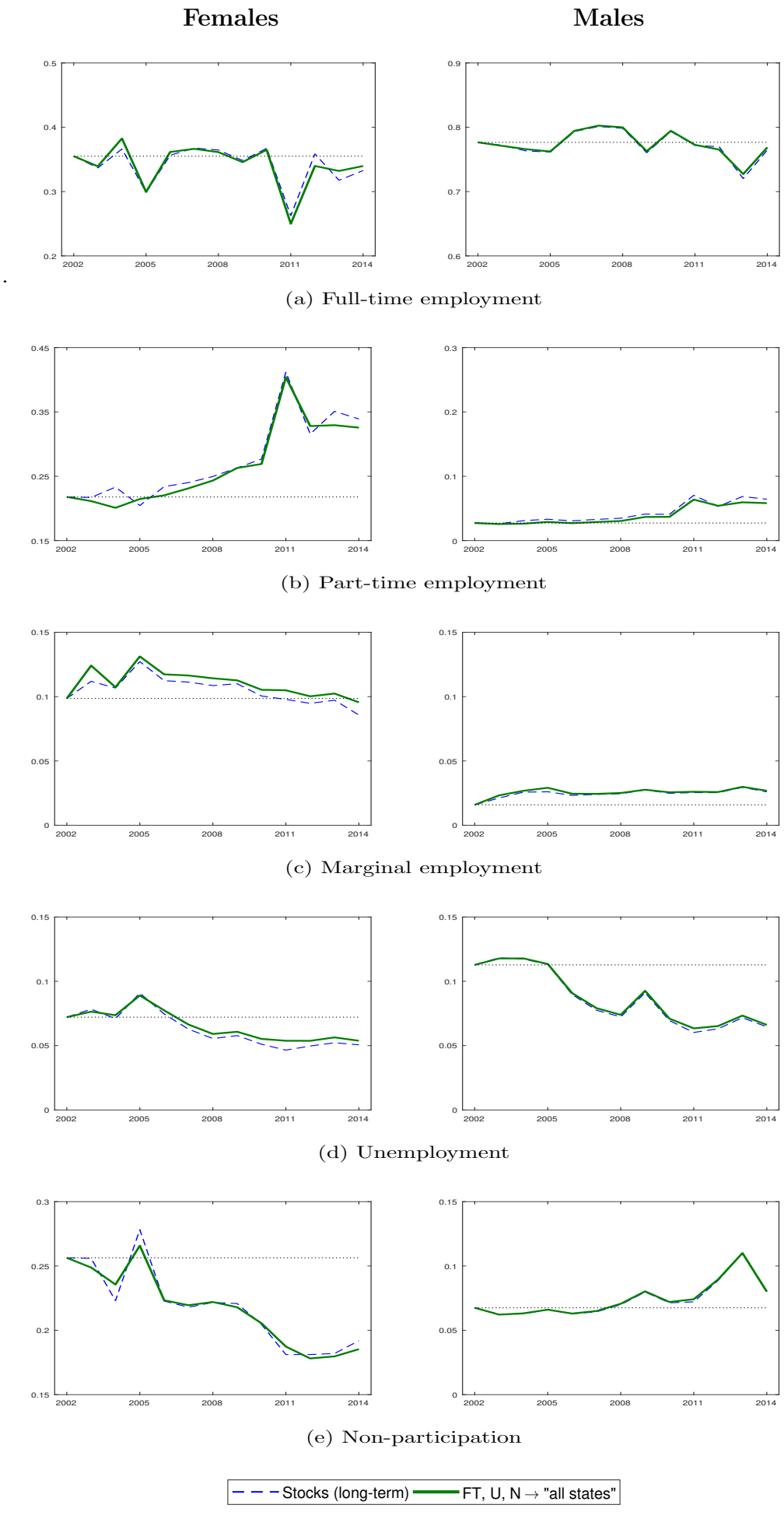


Figure 17: Counterfactual simulations where only transitions from full-time employment, unemployment and non-participation change

5 and 7. The main lesson is then that the Hartz reforms not only pushed workers out of unemployment, but also brought them back to work using non-participation as a siphon. The flow analysis presented in Section 4 suggests that this occurred due to the interplay of Hartz IV and Hartz II. The former increased the cost of registering as unemployed, while the latter improved the availability of part-time employment, in particular in the form of mini-jobs. So it seems that unemployment was high before the Hartz reforms because unemployment insurance was too generous.

As our previous discussion suggested, the fit is very good for females. The fit for males is also good, but male full-time employment is slightly underestimated, and unemployment overestimated. To understand these discrepancies, one last mechanism remains to be uncovered for men, which is illustrated in Figure 16. Here we show the counterfactual simulation where only transitions from full-time employment are allowed to change. For male workers, we observe that full-time employment goes up and unemployment goes down. This may reflect the effect of employer-employee negotiations, in particular wage moderation, which have made firms more resilient to productivity shocks and less likely to lay off full-time workers. Moreover, the magnitude of the reduction in male unemployment induced by unemployment and non-participation outflows, on one hand, and that induced by full-time employment outflows, on the other hand, are similar.

The above arguments suggest that the Hartz reforms and the negotiations of trade unions and employers associations on wages may have been going hand in hand to push unemployment down in the ten years that followed the joint efforts of workers, employers and government to revitalise the German economy in the early 2000s. Indeed, Figure 17 shows that when taking into account the change in the outflow probabilities from full-time employment, unemployment and non-participation jointly the fit becomes very good for male workers.

6 Quantitative evaluation of the effect of the Hartz reforms on unemployment

6.1 A mission impossible

The literature reports a whole range of estimates when it comes to evaluate the effects of the Hartz reforms. Krause and Uhlig (2012) report that unemployment fell by 2.8 percentage points as a result of the Hartz IV reform cutting long term unemployment benefits; while Krebs and Scheffel (2013) report 1.4 percentage points and Launov and Wälde (2013) estimate 0.1 percentage points. More recently, Hartung et al. (2018) find that unemployment dropped in West Germany after Hartz IV by 3.4 percentage points between 2004 and 2014, while Hochmuth et al. (2019) quantify this reduction to be of 2.2 percentage points. Finally, restricting their attention to male workers only, Bradley and Kügler (2019) find no effect of Hartz IV at all. The discrepancy between these various results is to a large extent explained by the differences in the amount of benefit reductions fed into the simulation of the respect-

ive models (Hochmuth et al., 2019). Regarding the other Hartz reform packages, Krebs and Scheffel (2013) estimate the cumulative effect of Hartz I-III on unemployment equal to a reduction of 1.5 percentage points, and Launov and Wälde (2016) find that Hartz III alone caused unemployment to fall by 0.9 percentage points.

A common feature of all these contributions is that the underlying model used to quantify the effects of the macroeconomic interventions is always a Markov model with two states, employment and unemployment. However, our analysis shows that registered and other official unemployment measures are likely to underestimate the number of non-employed workers susceptible to receive and accept a job offer. For a better understanding of the effects of the Hartz reforms, one needs to add unregistered unemployment or marginally attached workers into the analytical framework.[22]

One difficulty with this approach is that part of the individuals who are not registered as employed or unemployed should be counted as unemployed, others are true non-participants. Here, gender matters. It is indeed likely that a consequence of the Hartz IV reform for male, prime-aged workers is that a significant fraction of them stopped being registered as unemployed, yet they were willing to work, and more or less actively searching for a job. For women, it is the other way around. Many inactive women switched into activity in the 2000s, taking up one of the many mini-jobs that were encouraged by Hartz II.

Aside from this literature, Dustmann et al. (2014) suggested that the fall of German unemployment observed from the mid 2000s should be related to the regained competitiveness resulting from wage moderation. It could be that female labour force participation also increased as an indirect result of wage moderation. Some inactive married women may have been lead to take up a part-time job to compensate for the reduction of their husband's earnings in real terms. The same argument may explain the expansion of the marginal employment sector after 2002, which was the result of a large increase in moonlighting, where workers used mini-jobs as secondary employment. Therefore, exclusive mini-jobbers are more likely to be female and unskilled, while employees with a mini-job as second employment are more likely to be male and skilled.[23]

As we thus see, Germany did not increase labour market participation and reduce unemployment in such a huge proportion after 2000 without undergoing profound changes affecting many different sides of its economy. For that reason, it is extremely difficult to design and calibrate a realistic and complete model of the mechanisms at work in the reforms. Both the Hartz reforms and local employer-employee negotiations (including wage moderation) are important, which affect differently different genders, different types of families, etc.

[22]For an example of such a three-state model, see Garibaldi and Wasmer (2005).

[23]The strong increase in the overall stock of mini-jobs occurred after Hartz II, increasing from 1.98 million in 2002 to 3.14 million in 2004. The large differential increase in the stock of mini-jobs relative to the stock of workers with a mini-job as a primary employment also occurred after Hartz II. By 2014 there were about 3.54 million mini-job contracts in Germany, but only about 2 million workers had a mini-job as primary employment. Note that Hartz II encouraged moonlighting with a mini-job by making them entirely tax-free. On this phenomenon, see also Caliendo and Wrohlich (2010), Freier and Steiner (2010) and Tazhitdinova (2020).

6.2 Our structural interpretation and attempt at quantifying

Here we formulate a simple search and matching model with non-participation, unemployment, part-time employment and full-time employment as separate states. Its main purpose is to offer a guide to interpret the preceding reduced-form analysis. This is why we shall keep it as simple as possible, abstracting in particular from gender and family differences, and merging together all forms of part-time employment. We shall then use our model to quantify the relative effects of the Hartz reforms and wage moderation on unemployment.

Overview of the model

We consider a DMP economy in continuous time were a unit mass of risk neutral workers populate the economy. Workers can be in either one of four labour market states: non-participation (share n), unemployment (share u), part-time employment (share p), or full-time employment (share $f = 1 - n - u - p$). Non-participants receive non-labour income z_n, while unemployed individuals receive $z_u > z_n$. We assume that non-participation and unemployment are essentially two exchangeable unemployment states, and the two-way flows documented in Section 4 are modelled as two exogenous and independent Poisson processes, such that at rate χ_u a non-participant becomes unemployed and at rate χ_n an unemployed worker becomes non-participant.

There is also a mass of risk neutral firms, whose size is determined by free-entry. Firms post vacancies based on two types of contracts: part-time and full-time. Let v_p and v_f denote the measure of vacancies associated with each type of contract. The flow costs of posting each type of vacancies are c_p and c_f. Once filled these jobs have marginal productivities x_p and x_f, respectively, such that $x_f \geq x_p > z_u$. In the end, we even set $x_f = x_p$.

To capture that in the data we observe transitions from full-time or part-time employment to unemployment and non-participation, we allow for heterogeneity in job destruction rates. Let δ_p^n denote the (Poisson) rate at which a part-time job (p) is destroyed such that the worker becomes a non-participant and δ_p^u denote the rate at which a part-time job is destroyed and the worker becomes unemployed. Similarly, let δ_f^n (resp. δ_f^u) denote the job destruction rate of a full-time job (f) such that the worker becomes non-participant (resp. unemployed). In addition we will assume that f-workers do not consider p-jobs as a valid alternative, but at rate δ_f^p they get involuntarily reallocated to a part-time job. This could be the outcome of a displacement shock after which the f-worker found a p-job very quickly and hence can be considered as an involuntary job-to-job transition with a wage cut.[24]

Matches between firms and workers are random and mediated by two constant returns to scale matching functions. The respective labour market tightness are

$$\theta_p = \frac{v_p}{n + us_u^p}, \quad \theta_f = \frac{v_f}{n + us_u^f + ps_p^f},$$

[24]Hall and Kudlyak (2019) also have recently developed a model that includes non-participation, unemployment and two types of employment contracts, which in their case are short and long-term contracts, as well as exogenous probabilities that guides workers moving across several of these states.

where s_i^j refers to the relative search intensities of $i = n, u, p$ workers searching for $j = p, f$ jobs, after an arbitrary normalisation for n individuals.[25] The job offer arrival rates to unemployed are

$$\lambda_i = \lambda(\theta_i) = \phi_i \theta_i^{\eta}, i = p, f.$$

Wages are determined by Nash bargaining. To avoid having two part-time and three full-time wages, depending on the worker's current labour market state at the moment of search, we assume that part-time and full-time wages are obtained using unemployment as the common outside option. There are thus just two equilibrium wages, w_p and w_f, for part-time and full-time jobs, which depend on two bargaining parameters β_p and β_f (and outside options).

Details on the model's equilibrium solution and calibration can be found in Appendix B. It is easy to design a more sophisticated model with gender heterogeneity for example, but the more sophisticated the model becomes, the more difficult it is to calibrate. We calibrate the model separately for the periods 1999-2004 (pre-reform) and 2007-2014 (post-reform).

The postulated mechanisms of the reforms

We can think that the set of reforms in Hartz I, II and III changed the economy by increasing matching efficiency ϕ_p, ϕ_f. As documented in Section (2.1) these reforms explicitly aimed at improving the pairing of workers and vacancies through the Federal Employment Agency (Hartz III). They made it easier for firms to post – and for workers to find – part-time employment, particularly in the form of a mini-job by creating the *Minijobzentrale*, lifting their maximum number of hours and increasing their monthly wages (Hartz II). They finally deregulated and enhanced temporary employment, and implemented occupational training programmes (Hartz I).

We think of Hartz IV as a change in the flow benefits of non-employment z_p, z_f, and the rate at which the unemployed transit into non-participation, χ_n. This is motivated by the fact that the Hartz IV reforms reduced the unemployment insurance and social assistance payments, and made it more demanding for unemployed workers to keep collecting benefits, effectively increasing the cost of registration with the Federal Employment Agency.

Lastly, we model wage moderation as a decrease in the bargaining power of full-time and part-time workers, $\beta_i, i = p, f$, a decrease in the job separation probabilities δ_i^u, δ_i^n, and a decrease in the search intensities of the unemployed and part-time workers s_u^i. These latter changes would occur endogenously if we were to allow for fluctuations of match-specific productivities as modelled by Mortensen and Pissarides (1994) and endogenise workers' search intensities.[26] As noted earlier, elements of the Hartz reforms have negatively effected

[25] For simplicity we neglect the source of congestion represented by full-time workers being reallocated to a part-time job (exogenous probability δ_f^p).

[26] A reduction in workers' bargaining power would make employment less attractive with respect to unemployment and workers would naturally decrease their job search effort. Since we are deliberately keeping our analysis as parsimonious as possible, here we do not develop this version of the model but capture its features in a reduced form.

Table 1: Counterfactual effects of labour market reforms and wage moderation

	Full model		Counterfactual exercise			
	Baseline 99-04	Target 07-14	Hartz reforms	Wage moderation (level impact)	(% of Hartz impact)	Hartz and wage moderation
Model						
n	0.1658	0.1469	0.1397	0.1500	60.54	0.1271
u	0.0835	0.0623	0.0578	0.0729	41.25	0.0549
p	0.1931	0.2440	0.2389	0.2138	45.20	0.2397
f	0.5576	0.5468	0.5636	0.5634	96.67	0.5783

bargaining power, so our evaluation of the effect of wage moderation contains the interaction effect with the reforms.

Of course these modelling choices are disputable. Yet, this model is, we believe, a reasonable representation of the simulations of Section 5.

Simulations

Simulation results are reported in Table 1. We first compute the effect of the Hartz reforms on changes in shares u, n, p and f. To do so, we simulate the economy holding all the parameters at their 1999-2004 values except for ϕ_p, ϕ_f, z_u, z_n and χ_n, which we set to their calibrated 2007-2014 values. The Hartz reforms alone account for the observed reduction in non-participation and unemployment and at the same time for most of the observed increase in part-time work. These results are remarkably consistent with the simulations based on the stationary distributions reported in Section (5.2), as well as with the flow analysis presented in Section (4). However, our counterfactual exercises imply that the reforms should have generated a counterfactual slight increase in full-time employment from 0.558 to 0.566, which partially accounts for the overshooting in the reductions of n and u.[27]

To compute the effect of wage moderation on changes in u, n, p and f we simulate the economy holding all the parameters at their 1999-2004 values except for β_i, δ_i^u, δ_i^n, s_u^i $(i = p, f)$ and s_p^f which we set to their 2007-2014 values. The impact of wage moderation is 60% weaker than Hartz reforms for non-participation, 40-45% weaker than Hartz reforms for unemployment and part-time employment and almost the same as Hartz reforms for full-time employment. Despite being weaker than the reforms, wage moderation alone can explain about 50% of the reduction in unemployment and about 80% in the reduction of non-participation between the two periods. This occurs mainly due to the reduction in workers' bargaining powers, β_p and β_f. For example, by only changing these bargaining powers (and not the job separation rates or search intensities), the model can already explain 40% of the unemployment reduction and all of the reduction in non-participation between the two

[27]Constructing an overall matching efficiency as the average of ϕ_p and ϕ_f weighted by the share of part-time and full-time workers for each period, we find that matching efficiency increased by 8.9% between the 1999-2004 and 2007-2014 periods. This estimate is inline with the increase in matching efficiency estimated by Fahr and Sunde (2009) when considering the effects of Hartz II and III.

periods. Incorporating the changes in the job separations and search intensities then implies that firms react by creating more part-time jobs, accounting for 40% of the rise in part-time employment, and limit the increase in the creation of full-time jobs. Nevertheless, like in the case of the Hartz reforms, full-time employment increases from 0.558 to 0.563.[28] Note, however, that since the Hartz reforms themselves have negatively affected workers' bargaining power, the reported effects of wage moderation represent the upper bound of the pure impact of wage moderation (net of interaction with reforms).

The combined impact of Hartz reforms and wage moderation nearly explains the full change in part-time employment, predicting 92% of its increase. However, they also imply a strong increase in full-time employment, leading us to over-predict the reductions in the shares of non-participation and unemployment by 200% and 35%, respectively. This suggests that there should be a third force in place explaining the dynamics of the labour market stocks. Our model attributes this force to a rise in the cost of posting vacancies as shown in Table 2, found in Appendix B. Indeed accounting for the simultaneous increases in productivity and the flow costs of posting a vacancy, the model perfectly predicts the drop in unemployment and non-participation.[29] This demand-side effect mainly affects full-time employment. As argued in Section 3.1 the reason why we do not observe a large increase in full-time employment in our data is due to our focus on prime-aged workers. The latter had a much more subdued response to the financial crisis relative to older workers. The obvious culprit seems to be Hartz and subsequent reforms, which aimed to increase the participation rate of older workers.

7 Conclusion

In this paper, we show that prime-age unemployment in Germany fell largely because a greater fraction of unemployed workers did no longer register as jobseekers. This in principle should have increased non-participation. However, labour force participation actually increased because many unregistered-unemployed female workers ended up accepting low-paid, part-time work, all kinds of low-quality jobs that were offered in quantity in absence of a minimum wage bound. Male workers were less keen to accept marginal and part-time jobs, and spent more time unemployed, unregistered. Our flow analysis helps understand why, adding registered and unregistered male unemployment, the male non-employment rate did not fall after 2005, while full-time employment went down. For female workers, total non-employment went down and part-time employment went up.

To dig further, we proceed to a set of counterfactual simulations. We take the stocks and

[28] Only decreasing workers' bargaining power implies that the share of part-time employment increases from 0.193 to 0.199 and that of full-time employment increases from 0.558 to 0.579.

[29] Note that in this case the model still implies an increase in full-time employment at the expenses of a decrease in the predicted increase in part-time employment. This is expected as in the previous simulation we did not account for the slight increase in δ_f^p. Taking into account this last component, the model then reduces the share of full-time and increases the share of part-time employment in a way that is consistent with our original calibration.

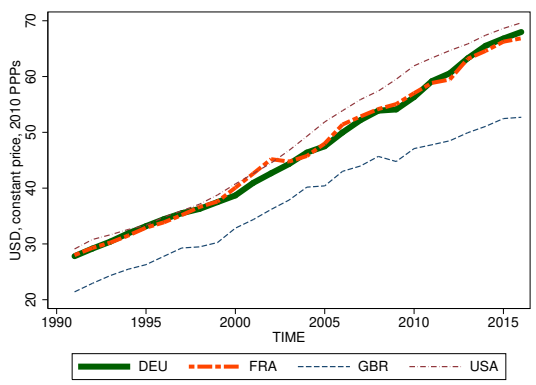
the flows as of 2002, and adjust outflows as observed later separately for registered unemployment, unregistered unemployment and full-time employment. For women, outflows from unregistered unemployment explain the rise of labour force participation and part-time employment, whereas outflows from registered unemployment explain the fall of unemployment. For men, we find that this is not enough. In order to obtain the right level of unemployment, it is necessary to take into consideration that full-time employment flows (job destruction) have decreased after 2002.

This is a first indication that the labour market reforms of 2003-2005, the Hartz reforms, may not be the only cause for the fall of unemployment in Germany after 2000. The negotiations between worker unions and employers associations at the turn of 2000, that lead them to agree on wage moderation, may or should matter.

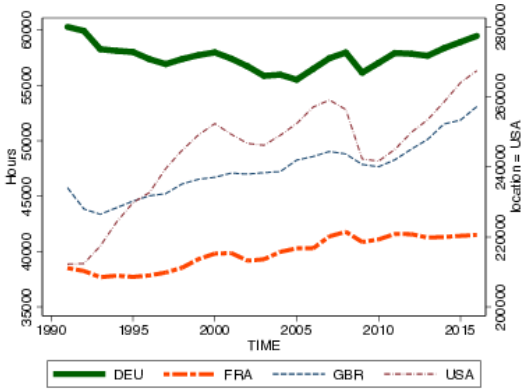
In order to disentangle labour market reforms from wage moderation and provide at least a ballpark comparison of their relative strengths we construct a stylised auxiliary model of the labour market. The model allows to separate interventions affecting matching efficiency and long-term unemployment benefits (the main tools of the Hartz reforms) from wage moderation and the induced labour hoarding, even if not being completely able to remove the influence of the reforms on bargaining power of workers. We find that the impact of wage moderation on unemployment, non-participation and part-time employment is at most half the impact of the Hartz reform. Each of the two has very high power in explaining the dynamics of all the states.

Of course this is a very complex machinery that we are trying to understand. Many countervailing forces operate at the same time. This is the reason why we tried to make our analysis as simple and transparent as possible. We yet believe that our analysis captures an important part of the truth. Germany worked hard to implement structural reforms for nearly twenty years in order to reduced unemployment and increase labour marker participation. It definitely increased labour utilisation (see Figure 18). The number of hours worked stoped falling after 2005 and continued rising after 2008. More workers were at work, working fewer hours. However, this policy had a cost that was essentially borne by prime-aged, male (mostly low-skilled) workers. For prime-aged workers, two-thirds of the workforce, there is little evidence that the reduction of unemployment was the result of the creation of good jobs. Most net job creation was of low quality (part-time, unskilled) and it essentially contributed to increase female participation and reduce early retirement.

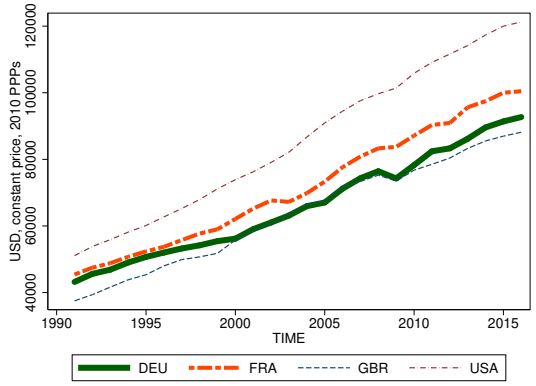
Still this policy was certainly more successful than the French status quo. The comparison with France, the UK and the US in Figure 18 is striking. While France, Germany and US are close in terms of GDP per hour, and do much better than the UK, the US are definitely richer than all in terms of GDP per head of population. Now, as the gap between the US, on one hand, and France and the UK, on the other hand, keeps widening, the gap between the US and Germany is consistently closing after 2005. So, it is hard, in the face of its very low labour utilisation, not to conclude that France, for example, could draw lessons from the German experience to increase participation and eventually wealth. Our study indicates



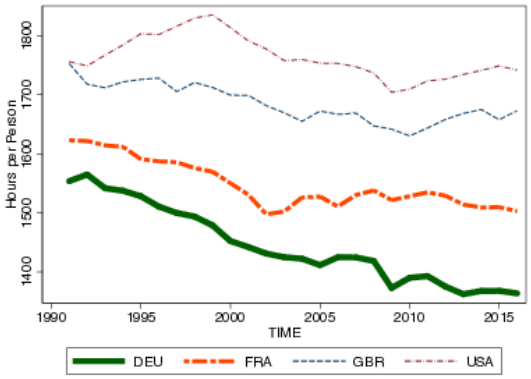
(a) GDP per hour worked



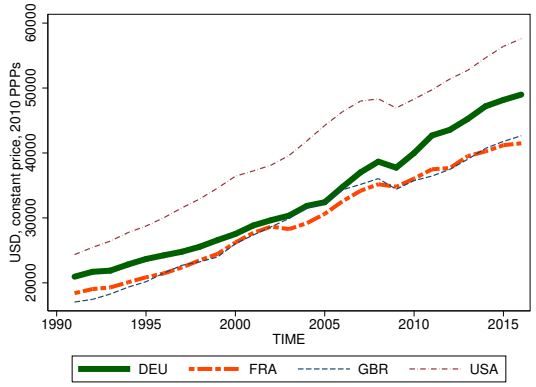
(b) Total hours



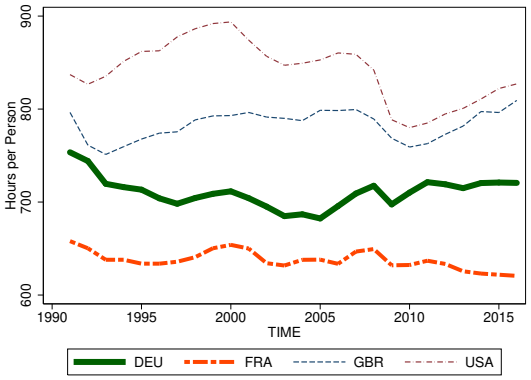
(c) GDP per person employed



(d) Hours worked per person employed



(e) GDP per head of population



(f) Labour Utilisation

Figure 18: Labour market characteristics of Germany, France, UK and US. (Source: OECD. Working age population, 14-65.)

that such policy adversely affects male, prime-aged workers. This negative effect might be countered by adapted training programmes.

Appendix

A Data

A.1 Stocks

Stocks comprise only individuals with simultaneous presence in at most two states of the labour market at the date of sampling. For every year the reported stocks are the averages of the twelve stock samples drawn at the last date of each month. The SIAB does not contain civil servants in government employment (*Beamte*) since this category of workers is exempt form paying contributions to unemployment insurance by German law. We also drop apprentices (or give priority to another category in case apprenticeship is concurrent with any other reported state of the labour market). Given that our ultimate focus is on the prime-aged population, information loss due to dropping apprentices is negligible. The SIAB does not keep any record of non-participation by construction. The stock of prime-aged non-participants is created with the help of labour force participation rates reported in the OECD Labour Force Statistics.

Conditional stocks, split by gender and education, are constructed using the gender and education variables reported in the SIAB. Since the original records of education in the SIAB are known to be of poor quality, we use the imputation procedure (*ip2a*) of Fitzenberger et al. (2006) to improve these. For constructing conditional stocks of non-participants, we use the gender-specific labour force participation rates available in the OECD data for the prime-aged population. As the relevant OECD data do not contain information about education, we resort to sampling the stock of prime-age nonparticipants form the GSOEP and take the distribution of education form that stock. The definition of education categories in the GSOEP and SIAB is identical and relies on the ISCED97 classification.

Establishment information in the SIAB is always reported at the June 30 of each year. Therefore, the stocks that we use for all the regressions are the stocks sampled on that date.

A.2 Flows

For any month within a year we consider stock samples at the last day of the month and at the last day of the preceding month. For any individual who changes state between the last days of the two adjacent months we record a transition to the new state. If an individual is absent in the stock of the preceding month but present in the stock of the current month, we record a transition form non-participation. Likewise, if an individual is present in the stock of the preceding month but absent in the stock of the current month, we record a transition

to non-participation. Averaging over all months within a year gives us the flow statistic for that particular year.

Since the SIAB does not have any record of non-participation, we cannot observe stayers in non-participation. While unimportant for the discussion of Sections 4.1-4.5, identification of the stock of stayers will be necessary to construct transition matrices. We discuss this identification in Section A.3 below.

As a robustness we also constructed the non-participation flows considering an alternative in which one verifies transition to non-participation with the help of the variable that indicates the reason why the individual file is closed. This variable is called "grund" in the SIAB. Whenever an individual is present in the stock of the preceding month and absent in the stock of the current month, this variable must indicate the transition to the state that is neither employment of any form nor unemployment. If it does not, we record the new state (any form of employment or unemployment, as suggested by "grund") and look at the next month to verify that an individual is present in the stock. If yes, the destination state is kept. If still absent, the transition is recorded back as a transition to non-participation. Similar procedure can be used to construct flows from non-participation. We discover that in doing so we only marginally adjust the flows to and form non-participation. For example, "Unemployment to Non-participation" and "Non-participation to Unemployment" flows are reduced by about 1/16 of their presently reported size, which bears no consequence for the argument we develop in the paper. Given that our original approach is fully consistent with the way we construct stocks and given that it is not ruled out that "grund" may indicate the closure of the spell which is still in progress (e.g. transition to employment at a foreign company), we present the analysis using our original approach.

Conditional flows are constructed using the gender and education variables reported in the SIAB. These variables have been already discussed in Section A.1.

A.3 Transition matrices

The construction of the transition matrices is outlined in Section 5.1. Here we only explain how the number of stayers in non-participation (i.e. the count of monthly transitions form non-participation to non-participation) is imputed.

By definition, the change in stocks between the two adjacent months is equal to the sum of all inflows less the sum of all outflows. Therefore, observing the stocks and subtracting (i) outflows from the stock of the preceding month, and (ii) inflows from the stock of the current month, we should get the number of stayers in non-participation in the current month. In practice the numbers we get form (i) and (ii) despite being very close to each other are never identical. As a result we take the average of the two. Finally, since the information on non-participants available form the OECD is reported only on the annual basis, whereas we need monthly frequency, we calculate our monthly stocks of non-participants under the assumption that the ratio of non-participants to full-time employed in the monthly samples is the same as the ratio of non-participants to full-time employed in the annual statistics.

B The DMP model

B.1 The model

General assumptions Consider a DMP economy in continuous time were a unit mass of risk neutral workers populate the economy. Workers can be in either of four labour market states: non-participation n, unemployment u, part-time employment p, or full-time employment f, such that $1 = n + u + p + f$. Non-participants receive flow income z_n, while unemployed individuals receive $z_u > z_n$. Non-participation and unemployment are two exchangeable unemployment states. The two-way flows between them are modelled as two exogenous and independent Poisson processes, such that at rate χ_u a non-participant becomes unemployed and at rate χ_n an unemployed worker becomes non-participant.

The economy comprises a mass of risk neutral firms, whose size is determined by free-entry. Firms post vacancies based on two types of contracts: part-time and full-time. Let v_p and v_f denote the measure of vacancies associated with each type of contract. The flow costs of posting each type of vacancies are c_p and c_f. Once filled these jobs have flow marginal productivities x_p and x_f, respectively, such that $x_f \geq x_p > z_u$. To capture that in the data we observe transitions from full-time or part-time employment to unemployment and non-participation, we allow for heterogeneity in job destruction rates. Let δ_p^n denote the Poisson rate at which a part-time job (p) is destroyed such that the worker becomes a non-participant and δ_p^u denote the Poisson rate at which a part-time job is destroyed and the worker becomes unemployed. Similarly, let δ_f^n (δ_f^u) denote the job destruction rate of a full-time job (f) such that the worker becomes non-participant (unemployed). In addition we will assume that f-workers do not consider p-jobs as a valid alternative, but at rate δ_f^p they get involuntarily reallocated to a part-time job. This could be the outcome of a displacement shock after which the f-worker found a p-job very quickly and hence can be considered as an involuntary job-to-job transition with a wage cut.

Endogenous meetings Matches between firms and workers are random and mediated by two constant returns to scale matching functions, one for each type of contract:

$$m_p\left(n + us_u^p, v_p\right), \quad m_f\left(n + us_u^f + ps_p^f, v_f\right),$$

where s_i^j refers to the relative search intensities of $i = n, u, p$ workers searching for $j = p, f$ jobs, after an arbitrary normalisation for n individuals.[30] Under constant returns to scale in matching, the respective labour market tightness θ, job filling rates $q(\theta)$ and job finding

[30]For simplicity we neglect the source of congestion represented by full-time workers being reallocated to a part-time job (exogenous probability δ_f^p).

rates $\lambda(\theta)$ are given by

$$\theta_p = \frac{v_p}{n + us_u^p}, \quad q(\theta_p) = \frac{m_p}{v_p} = q_p, \quad \lambda(\theta_p) = \frac{m_p}{n + us_u^p} = \theta_p q(\theta_p) = \lambda_p,$$
$$\theta_f = \frac{v_f}{n + us_u^f + ps_p^f}, \quad q(\theta_f) = \frac{m_f}{v_f} = q_f, \quad \lambda(\theta_f) = \frac{m_f}{n + us_u^f + ps_p^f} = \theta_f q(\theta_f) = \lambda_f.$$

Unemployment values We think of unemployment and non-participation as of two non-employment states with their own flow benefit z, and their own transformation probability χ into the other non-employment state. Using standard arguments, the Bellman equations that describe the expected values of unemployment and non-participation are given by

$$rU_n = z_n + \lambda_p(W_p - U_n) + \lambda_f(W_f - U_n) + \chi_u(U_u - U_n), \tag{1}$$
$$rU_u = z_u + \lambda_p s_u^p(W_p - U_u) + \lambda_f s_u^f(W_f - U_u) + \chi_n(U_n - U_u), \tag{2}$$

where r denotes the discount rate and W_p, W_f the worker's expected values from employment in part-time and full-time jobs.

Vacancy creation The expected values of part-time and full-time vacancies are given by

$$rV_p = -c_p + q_p(J_p - V_p),$$
$$rV_f = -c_f + q_f(J_f - V_f),$$

and free entry implies $V_p = V_f = 0$. The expected values of filled part-time and full-time jobs given wages w_p and w_f are in turn

$$rJ_p = x_p - w_p - (\delta_p + \lambda_f s_p^f)J_p, \tag{3}$$
$$rJ_f = x_f - w_f - \delta_f J_f, \tag{4}$$

where $\delta_p = \delta_p^n + \delta_p^u$ and $\delta_f = \delta_f^n + \delta_f^u + \delta_f^p$.

Employment values and wages In the case of employed workers the expected values of part-time and full-time employment, given wages w_p and w_f, are

$$rW_p = w_p + \delta_p^u(U_u - W_p) + \delta_p^n(U_n - W_p) + \lambda_f s_p^f(W_f - W_p), \tag{5}$$
$$rW_f = w_f + \delta_f^u(U_u - W_f) + \delta_f^n(U_n - W_f) + \delta_f^p(W_p - W_f). \tag{6}$$

As it is standard in the DMP framework, wages w_p and w_f are determined by Nash bargaining. To avoid having two part-time and three full-time wages, depending on the worker's current labour market state at the moment of search, we assume that part-time and full-time wages are obtained using unemployment as the common outside option. This simplification

implies that

$$W_p - U_u = \frac{\beta_p}{1-\beta_p} J_p = \frac{\beta_p}{1-\beta_p} \left[\frac{x_p - w_p}{r + \delta_p + \lambda_f s_p^f} \right],$$

$$W_f - U_u = \frac{\beta_f}{1-\beta_f} J_f = \frac{\beta_f}{1-\beta_f} \left[\frac{x_f - w_f}{r + \delta_f} \right],$$

where β_i for $i = p, f$ denotes the worker's exogenous bargaining power parameter for each type of contract.

Equilibrium solution The above model can be solved by first noting that equations (6) and (5) yield

$$W_f - U_u = \frac{w_f - rU_u + \delta_f^n (U_n - U_u) + \delta_f^p (W_p - U_u)}{r + \delta_f}, \tag{7}$$

$$W_p - U_u = \frac{w_p - rU_u + \delta_p^n (U_n - U_u) + \lambda_f s_p^f (W_f - U_u)}{r + \delta_p + \lambda_f s_p^f}. \tag{8}$$

Solving for J_p and J_f using equations (3) and (4), and using the Nash bargaining conditions yields the following wage equations:

$$w_f = \beta_f x_f + (1-\beta_f) \left[rU_u - \delta_f^n (U_n - U_u) - \delta_f^p \left(\frac{\beta_p}{1-\beta_p} \right) \left(\frac{x_p - w_p}{r + \delta_p + \lambda_p s_p^f} \right) \right], \tag{9}$$

$$w_p = \beta_p x_p + (1-\beta_p) \left[rU_u - \delta_p^n (U_n - U_u) - \lambda_f s_p^f \left(\frac{\beta_f}{1-\beta_f} \right) \left(\frac{x_f - w_f}{r + \delta_f} \right) \right]. \tag{10}$$

Note that the equation for w_f is the same as in the canonical DMP model with the exception of the two last terms in the squared brackets, which capture that full-time workers might end up as non-participants or in part-time employment after a job destruction shock. The equation for w_p also captures that part-time workers might end up as non-participants after a job destruction shock, but also that they can become full-time workers after meeting a full-time vacancy.

One can easily verify that plugging the wages from equations (9), (10) in equations (7) and (8), and then using equations (1) and (2) allows to solve for values $W_i, i = p, f, U_j, j = u, n$. Then, the free entry conditions $c_i/q_i = J_i$ for $i = p, f$, give equilibrium solutions for the labour market tightness, θ_p and θ_f.

B.2 Calibration

To evaluate the impact of the Hartz reforms and wage moderation we separately calibrate the model for the 1999-2004 and the 2007-2014 periods. Our assumption is that both periods represent different steady-states and that the reforms implemented during the first period took the German labour market to the 2007-2014 steady-state. In the spirit of Krause and Uhlig (2012), we leave a few years out between these two periods to allow for the effects of

Table 2: Calibration moments and parameters

	1999-2004	2007-2014		1999-2004	2007-2014
Worker transition rates			Matching function		
λ_p	0.0267	0.0391	η	0.35	0.35
λ_f	0.0378	0.0481	ϕ_p	0.084	0.103
χ_u	0.0451	0.0517	ϕ_f	0.101	0.110
s_u^p	0.3475	0.2433	Vacancy costs		
s_u^f	0.9663	0.6022	c_p	$7.657x_p$	$8.938x_p$
χ_n	0.0963	0.1299	c_f	$5.824x_f$	$7.276x_f$
δ_p^u	0.0043	0.0027	Flow payoffs		
δ_p^n	0.0214	0.0224	x_p	22.6	25.5
s_p^f	0.1504	0.1331	x_f	22.6	25.5
δ_f^u	0.0064	0.0041	w_p	13.98	12.45
δ_f^n	0.0108	0.0125	w_f	17.73	17.13
δ_f^p	0.0015	0.0025	z_u	7.81	6.21
Vacancy transition rates			z_n	3.62	0
q_p	0.7140	0.6231	Bargaining		
q_f	0.6189	0.5161	β_p	0.177	0.143
			β_f	0.485	0.393

the reforms (if any).

We set a time period to be a month and fix $r = 0.0042$ to represent a yearly discount rate of 5.2%. Table 2 shows the vector $\Omega = \left\{\lambda_p, \lambda_f, s_u^p, s_u^f, s_n^p, s_n^f, s_p^f, \delta_p^u, \delta_p^n, \delta_f^u, \delta_f^n, \chi_u, \chi_n\right\}$ of worker transition rates, which are identified directly from the average monthly transition rates observed in the SIAB data.

We can also directly compute the job filling rates for part-time and full-time jobs in Germany using the IAB Job Vacancy Survey (JVS). The JVS is a representative cross-sectional survey of establishments that has been running since 1990s' and that collects information about their search and hiring practices. It reports daily vacancy durations as the difference between the date the establishment started searching for a worker and the date the worker accepted. It also provides information on whether the job was part-time (including mini-jobs) or full-time and the age of the worker appointed.[31] Using only those vacancies filled by workers between 25-54 years old, we find that the average duration of a part-time (full-time) vacancy is 42.02 (48.47) days and 48.15 (58.13) days during the 1999-2004 and 2007-2014 periods, respectively. Table 2 then shows the corresponding monthly job filling rates, q_i.

As standard in the DMP literature, we consider a Cobb-Douglas specification such that $\lambda(\theta_i) = \phi_i \theta_i^{\eta_i}$, where ϕ_i denotes matching efficiency and η_i the elasticity of λ_i with respect to labour market tightness θ_i for $i = p, f$. We further assume that $\eta_p = \eta_f = \eta$ and following

[31]Most of the information collected in the JVS pertains to the last vacancy the establishment filled during the last 12 months in relation to the interview data, which lies in the last quarter of a year. To ensure the representativeness of our estimates, we use establishment weights which are computed as the product of the survey weights for each establishment and the total number of hires the establishment made in the last 12 months. Further details about the JVS data can be found at https://www.iab.de/en/befragungen/stellenangebot.aspx.

Kohlbrecher et al. (2016), who estimate a matching function for Germany using SIAB and official vacancy rates on a monthly basis from 1993 to 2007, set $\eta = 0.35$ (see also Shimer, 2005, for a similar value).[32] The matching efficiency parameters ϕ_i can then be directly recovered by using the values of λ_i and q_i to obtain $\theta_i = \lambda_i/q_i$ for $i = p, f$ and the definition of the job finding rate, which leads to the parameter values reported in Table 2.

To obtain estimates of the marginal productivities of part-time and full-time jobs, we first regress quarterly real GDP on total full-time hours worked and total part-time hours worked to investigate whether there are significant differences between x_p and x_f within a period. Consistently across many specifications we find that we cannot reject the hypothesis of $x_f = x_p$. In light of this finding we calculate average real GDP per hour (in 2010 prices) separately for each period and use these values as our measures of productivity in our benchmark calibration, such that $x_f = x_p = 22.6$ euros per hour in 1999-2004 and $x_f = x_p = 25.5$ euros per hour in 2007-2014 as reported in Table 2.[33] Using information on hourly real wages for full-time and part-time workers from the GSOEP (also in 2010 prices), we then calibrate the flow costs of filling a vacancy through the corresponding free-entry conditions such that $c_p = (x_p - w_p)q_p/(r + \delta_p + s_p^f \lambda_f)$ and $c_f = (x_f - w_f)q_f/(r + \delta_f)$. Table 2 show that these represent between 5.8 and 7.3 times the productivity of full-time contracts and between 7.7 and 8.9 times of productivity of part-time contracts.[34]

We calibrate the values of the flow payoffs while non-employed, z_n and z_u, by interpreting them as the social assistance benefits and unemployment insurance benefits, respectively. The former is calculated as the real hourly social assistance per household member (in 2010 prices) obtained from the GSOEP. Table 2 shows that these fall from 3.62 euros an hour to zero after the Hartz reforms. The computation of the unemployment insurance benefits is more involved as we have to take into account the proportion of unemployed workers who are eligible for receiving the benefits and how these benefits differ across the short-term and long-term unemployed. Here we take into account that mini-jobbers are not entitled to unemployment benefits and that not all workers would pass the means test.[35] For the

[32]These value of η is lower than the values typically used when calibrating search and matching models for the US. As alternative, we also calibrated the model using $\eta = 0.5$ (as suggested by Pissarides and Petrongolo (2001)). As expected, by making the job finding more responsive to labour market tightness, the effects of the labour reforms and wage moderation on unemployment and non-participation reduction become stronger. Nevertheless, the directions of change in the labour market shares are the same as in our baseline calibration and our main conclusions remain robust to these alternative values.

[33]These values confirm that average productivity in Germany hardly increased throughout the 1999-2014 period as suggested by Dustmann et al. (2014).

[34]As an alternative calibration we also used the estimated (but not statistically different from each other) values of x_p and x_f obtained from regressing quarterly GDP on total full-time hours worked and total part-time hours worked and a quadratic time trend for the period 1999-2014. These values are $x_p = 18.66$ and $x_f = 21.13$. Using the latter does not meaningfully change our main conclusions. One can also fix the values of c following the evidence of Silva and Toledo (2009) for the US and usage of Hall and Milgrom (2008) who suggest a c around 35% of labour productivity. Using this value, however, yields counterfactually high values of average wages.

[35]The flow income of unemployed workers is computed as an expected flow income. It accounts for the probability of entitlement to (i) unemployment insurance benefits, (ii) unemployment assistance benefits and (iii) social assistance. All required probabilities are either obtained using GSOEP data or taken from the estimates of Launov and Wälde (2013). Detailed calculations are available upon request.

Table 3: Fit of the model

Fit of the model					
	1999-2004	2007-2014		1999-2004	2007-2014
Model			Data		
n	0.1658	0.1469	n	0.1633	0.1458
u	0.0835	0.0623	u	0.0821	0.0646
p	0.1931	0.2440	p	0.1757	0.2262
f	0.5576	0.5468	f	0.5790	0.5634
v	0.0241	0.0304	v	0.029	0.028

period 1999-2004, our calculations yield a value of $z_u^f = 8.27$ per hour for those who lost a full-time job and $z_u^p = 4.98$ per hour for those who lost a part-time job. For the period 2007-2014, we obtain a value of $z_u^f = 6.81$ per hour for those who lost a full-time job and $z_u^p = 3.78$ per hour for those who lost a part-time job. Since in our model we abstract from differences in z_u by the type of contract the worker held immediately prior displacement, we take $z_u = fz_u^f + pz_u^p$, where f and p denote the proportions of worker employed in a full-time and part-time contract, respectively, as reported in Table 2.[36]

Finally, we use the wage equations to recover the workers' bargaining powers β_p and β_f, where given the values of the rest of the parameters we use the Bellman equations and wage bargaining conditions described earlier to solve for U_u and U_n. Note that we obtain relatively low values of β_p across periods, which reflect the low values of w_p obtained from aggregating contributing part-time and marginal employment into a single category.[37]

Table 3 shows that the fit of the model is very good. It shows the values of n, u, p and f obtained from the flow-balance equations implied by our model together with their data counterparts. The model reproduces very well the average unemployment and non-participation rates in both periods, but slightly under-predicts (over-predicts) the share of full-time (part-time) workers. Table 1 also shows the values $v = v_p + v_f$, where v_i can be obtained from the definition of labour market tightness for $i = p, f$. The aggregate vacancy rate v implied by our model is inline with the official vacancy rates reported by EUROSTAT for each period.

[36] As an alternative we also consider a calibration where in addition to social assistance and unemployment insurance we take the value of leisure. Hall and Milgrom (2008) propose a way to calculate the value of leisure by maximising consumption and hour pairs, requiring further assumptions on the parametrisation of individuals utility function (including the levels of risk aversion and Frisch elasticity) which lie outside our model. Nevertheless, this procedure leads to a value of leisure of around 35% of the average w_p across the 1999-2014 period and hence values of $z_u = [10.46, 17.90]$ and $z_n = [8.24, 4.63]$. Although under this calibration strategy we obtain much larger flow payoffs of non-market time, our main conclusions remain unchanged.

[37] Using GSOEP data we obtained that the average hourly real wage for contributing part-time and mini-jobs is 15.07 and 10.53 euros, respectively, during the 1999-2004 period, and 14.05 and 8.48 euros during the 2007-2014 period.

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