# How wages and employment might change by the economic crisis

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very preliminary version

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**Abstract**

We develop a CGE model that approximates a macroeconomic forecast of the German economy in the medium run. The "fitted" model is used to derive wage and employment changes for different skill types and industries. These simulated changes are then handed over to a tax-benefit model that determines the net income changes at the household level. We find negative wage effects which are quite proportionally spread across the income distribution.

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# 1 Introduction

This paper originates from the question posed by the organisers of this workshop: "Economic Crisis, Unemployment and Policy Responses: What does it Mean for the Income Distribution?

Taken at face value this is a question about the state of the world economy in the near future and the impact of the "general macroeconomic conditions" on the distribution of incomes and the incidence of unemployment, most likely in a certain country. As such it is a question about a counterfactual allocation towards an actual economy evolves. Put differently the organisers of the workshop called for forecasts of the income distribution.

At least for developed economies this kind of questions have been rarely raised. If there has been interest in changes of the income distribution, it has been mainly attached to certain policies and in particular to changes in institutions. While "policy responses" have been acknowledged as part of the story, the bulk of interest here focuses on the "shock" that has hit the world in the autumn of 2008.Policies in the sense of reactions to the crisis do, however, also play a role.

The question raised is difficult to answer with the standard toolboxes employed at research centres around the globe. By the prevailing dichotomy of short-run business cycle analysis, focusing on changes in macroeconomic aggregates on the one hand and long-term growth analysis, where levels of incomes and potentially also their personal distribution are covered, on the other hand, the question falls somehow into the gap between these two strands of research. The short-term perspective has to be taken by assumption, otherwise the basis of the question could erode. But the existing models for short-run analyses are simply not built to deal with the kind of heterogeneity that determines the personal income distribution. Put pointedly, it is not of great help to know that wages fall faster/slower than profits or interest rates.

To bridge the aforementioned gap between highly aggregated business cycle models and the request of disaggregated information for the analysis of changes of the income distribution, we propose the use of a non-standard computable general equilibrium (CGE) model. The CGE part is modified in a way that renders the E in the abbreviation questionable. To what extent one can still speak of an "equilibrium" model will be worked out. The basic idea of our approach draws on work by Peter Dixon and his colleagues who developed the MONASH model for Australia (see Dixon and Rimmer 2007 for a detailed description). Our CGE model is used to compute a reasonable forecast of the near future based on external information provided by typical macroeconomic forecasters such as central banks or research institutes. The model performs a break-up of macroeconomic aggregates. Our focus is on sectors of production and skill groups.

The information on wages by industry is then "fed through" to a standard microsimulation model, which is used at this stage only as a net-income calculator. Based on the changes in the household sample we can calculate alternative measures of income inequality and assess the changes that result from the change of gross wages (and unemployment).

There is a number of tasks on our to-do list that we would like to consider soon, but couldn't be accomplished until now:

- the CGE model should become sequentially dynamic, and include the "way back" to a real equilibrium,
- changes in unemployment, also per sector and skill type should also be fed through to the microsimulation part,
- the number of industries and skills could be increased to paint a finer picture,
- the behavioural part of the microsimulation model could be used to assess changes in the supply of labour, and possibly to feed back these changes to the CGE part.

There are other examples in the literature where CGE models were used to asses the impacts of macroeconomic shocks. This work is mostly concentrated in developments economics. Jemio and Wiebelt (2002), for instance use a CGE model to study the effects of external shocks, such as a terms-of-trade shock or a reduction in capital inflows on Bolivia.

The paper is organised as follows. In the next section we describe how a CGE model can be used for a medium-term forecast. Section 3 contains a description of the specific macroeconomic scenario that we simulate. Then, in section 4, we present our "macro" simulation results. In section 5 the microsimulation model is shortly introduced and the changes in the income distribution that stem from our CGE simulation presented. Finally we try to assess our approach and look at further research perspectives.

# 2 Using the CGE model for a medium-term forecast

## 2.1 Basic idea

Our approach is based on the use of MONASH, a large computable general equilibrium model for Australia (Dixon and Rimmer 2007). This model stands out in the CGE modelling landscape by the fact that it can be used for historical and forecasting simulations. Both terms are taken rather literally by MONASH's builders. By forecast, they mean a detailed projection of the development of the whole economy over a certain, explicitly specified, period of time.

The basic idea of the "forecasting closure" in MONASH is to swap a set of endogenous economic variables for a set of parameters. Roughly speaking, central model variables are exogenised and replaced by forecasts determined outside the model. A good example is GDP growth taken from available macroeconomic forecasts, e.g.

those from the central bank or the government. Since GDP is endogenously determined under different closures, a set of otherwise exogenously determined variables − or parameters for the sake of clarity − has to be turned into endogenous variables. For instance one could adjust total factor productivity parameters in order to meet the targeted GDP growth.

As a general rule the number of swapped variables must be equal. The model can also be overfit in the sense that the number of endogenous variables increases. This step, however, requires the introduction of additional information, most naturally in the form additional equations, in order to avoid multiple solutions. On the other hand, multiple solutions are a natural issue in this context, since a specific macroeconomic outcome could be the result of different changes at the micro or meso level. Thus there is something like a "theory of future developments" needed in order to determine a single allocation. In this respect, modelling becomes a bit of an "ugly" business, since it typically involves changes in preferences and technologies, which are most often taken as sacrosanct in CGE modelling.

A natural question to ask is: What is it good for? If the forecasts themselves are determined outside the model, what will be the function of the model. The general answer to this question is: structure. The function of the model is to break down global predictions into changes of smaller aggregates. More technically this means that out of a set of $M$ economic variables, a subset $M_0$ is determined outside the model. The remaining variables of interest $M_1$with $M_1 \cup M_0 = M$ is still derived from the model. The subset $M_1$ has to be chosen according to the guiding research questions.

In our example the variables of interest are wages, employment and unemployment by skill groups and industry. These two dimensions are given by the current set-up of the model. Other dimensions of heterogeneity are possible. We think that both characteristics are important. Since the overall contraction of economic activity has been distributed rather unevenly over sectors of production, industry appears

as a natural candidate to look at. Besides, the level of qualification is also of interest, since unemployment risks, and in particular the risk to become long-term unemployed, are rather different for different skill groups. Other groups of interest, particularly in policy terms, are age groups (youngsters, elderly) and differences by gender. These dimensions are beyond the scope of our CGE model. They enter the picture, however, when we move on to the household data of the micro part.

## 2.2 PACE-L

The model that we take as our starting point is PACE-L (Böhringer, Boeters and Feil 2005; Boeters and Feil 2009). It is a static, single-country CGE model very much in the tradition of Shoven and Whalley (1984, 1992). The specific innovation of PACE-L is the introduction of unemployment through an explicit wage-bargaining part. In each sector of production a trade union and an employers' association bargain over gross wages for a full-time worker. Contractual wages are industry specific, thus inter-industry wage differentials exist. These differences lead to different employment probabilities (or queues) for each industry. The model is calibrated to reproduce benchmark unemployment levels, i.e. skill-specific aggregate unemployment rates.

In principle, PACE-L is capable to deal with varying dimensions of sectors and inputs. In the version used here we distinguish seven sectors of production and four primary inputs. Three of them consist of labour, differentiated by skill type (high, medium, low).

PACE-L has not been used so far for sector specific policies. We are therefore not as confident of model reactions as for general policies such as tax reforms. Elasticities of substitution differ significantly by sector. Reallocations between sectors can thus take the form of quite large changes in factor demands. Since valid information on elasticities of substitution for a all sectors and for heterogeneous labour are hard to obtain − production functions are of the NNCES-type (Perroni and Rutherford

1995) and can thus be calibrated to any (regular) matrix of substitution measures − we have to be cautious and sensitivity analysis is certainly advisable.

## 2.3 Technical description

Our analysis has to take a medium-term perspective. Since by its very nature it is a disequilibrium analysis, the standard long-run adjustments are obviously ruled out. A look too short into the future, on the other hand, would most probably lead to an overestimation of the shock waves.

At the centre of our discussion stands the question, what is going to adjust to what extent to the initial impulse at a reasonably quick speed. A fast and complete rebound scenario would be senseless. The trough must be either long or there must be some sort of path-dependency to turn our approach into a useful endeavour.

Is a CGE model a sensible tool to tackle this issue? One has to be cautious. The class of models to which ours belongs was not designed to deal with business cycle questions. The modelling of business cycles requires an explicit treatment of deviations from the long-term trend. CGE models typically have something to say about "structural change". Business cycle models, however, very often lack the kind of structure one is interested in. For instance, standard macroeconomic DSGE models are highly aggregated, very often abstracting from multiple sectors of production completely. This lack of structure makes the model uninformative with respect to distributional analyses. The only distributional aspect always considered is the functional distribution of income at the national level. Obviously this falls short of policy questions that evolve around the personal income distribution.

In the very long run, business cycles should be irrelevant for the level of wealth and its distribution. This is at least the prevailing opinion, although this view might have become under fresh attack due to the crisis. In this respect gauging the distributional effects of the economic crisis is an ill-posed question.

Adding dynamics in the sense of hysteresis is an interesting idea. It opens up, however, an enormously big space of possible allocations. It is hard to see how we could determine one or at least a couple of scenarios which would be accepted by policymakers and peers. The degrees of freedom can be reduced, if we do restrict ourselves to the near future. This future should be far enough away to allow for a number of adjustments by the economic agents.

At the very end the definition of the modified CGE model ("forecasting closure") boils down to the decision of how much flexibility to build into the model.

Our starting point is the projected drop in GDP. We also fix some levels of industry production levels on the basis of external information. The level of activity of industry $s$ becomes thus in part exogenous. For given inputs the corresponding model equations do not hold. Factor prices and quantities have to adjust. We assume that at the end of the simulation period temporary losses of the representative firms have disappeared, i.e. zero-profit conditions hold. The only adjustment we allow for at the profit margin is a change in mark-up rates.

Overall employment is fixed at 98% of the pre-crisis level (see next section for the justification). The overall capital stock is allowed to adjust. There is also the possibility of sectoral reallocation. We thus allow the flow of capital between sectors. We restrict the change, however, to $\pm 5\%$, in order to avoid unrealistically strong intersectoral movements. We also allow for an underutilization of total capacity. This is done by introducing a multiplier on the aggregate capital stock.

We abstract from the possibility of (prolonged) short-time work, thus effectively assuming that the current incidence of short-time work will have disappeared by the end of the simulation period. An alternative margin of adjustment would be the less intensive use of labour or shorter hours of work. This could be explored in an accompanying simulation. Our approach actually forces the model to produce (additional) unemployment. This conforms with the macro forecasts.

Due to the real-wage resistance, which stems from the wage-bargaining model,

complete adjustment of prices is not possible. This would also be counterfactual with respect to the observed reaction of wages and prices, and also with respect to projected price movements.

Modelling of a trade shock, which is definitely part of the story (see next section) is somehow problematic. Our model is a single country model in which world market prices are treated as exogenous (small-open-economy assumption). To some extent there is an obvious contradiction between the nature of German exports and the exogeneity of prices, because at least in small market segments German suppliers will actually move market prices. Besides, by fixing both activity levels and exports we also fix the amount of production that is absorbed internally. That leaves not much room for adjustments and puts goods prices at the centre of the adjustment process. The exchange rate is of particular importance in this respect, since export supplies depend crucially on it. In order to let the export supply equations hold, we introduce an endogenous parameter in the counterfactual equilibrium. This approach is in line with the strategy of Dixon and Rimmer (2007) who speak in the same context of sector-specific "export shift variables" (pp. 266-267).

We also endogenise the balance of Germany's net foreign wealth. The balance of payments requirement, i.e. current account equals change in net foreign assets, is thus always met by residually adjusting this position.

The German government can raise public funds on an globally integrated capital market. We assume that the interest payments Germany has to offer stay constant. Without the assumption of access to a capital market with perfectly elastic supply, the large increase of net public borrowing would produce quite considerable crowding out of private investment.

To increase the flexibility of the model we allow the endogenous change of inventories. We put some restrictions on these newly formed variables in order to avoid excess flexibility. In the simulations the changes were only small.

# 3 A scenario

We opted for 2011 as the final year of interest. What we are actually after is the change between 2007 and 2011. By choosing 2007 we avoid the impact of the crisis in the base year. On the other hand the effect of the crisis is not erased. Going further back bears the risk of comparing quite similar levels of economic activity, although this might be interesting from a distributional view, because similar aggregates are made up by different structures.

Our starting point is the latest forecast of the Bundesbank (2009). The Bundesbank predicts a cumulative change of GDP between 2007 and 2011 of $-1.1\%$. The bank also foresees an aggregate change in the volume of work of about $-2.4\%$, going along with a drop in employment of $-0.8\%$ and an increase in the unemployment rate from 9% to 10.1% (i.e. a growth rate of 12.2%).

A striking feature of the economic crisis is the significant decrease of world trade. This has hit Germany very hard. Germany's economy has been specialising further and further in export-oriented goods, much less in services. In 2009 Germany's export dropped by 15% (Bundesbank 2009). There is virtually no macro analyst who currently expects them to completely rebound within due course. Based on the structural information for 2009 and the years before, we fix total exports at $-4.4\%$ and add, similarly to production, information on the sectoral distribution.

We do not vary the exchange rate of the Euro, since we do not expect a significant shift of the effective exchange rate within the simulation period.[1]

Due to the contraction of world trade a decrease in import prices has already occurred and is rather likely to persist in the next two years. Ignoring changes in the prices of crude oil and petroleum products import prices changed on average by $-5.2\%$ between 2008 and 2009. Based on this observation we guess that the overall change within our simulation period amounts to $-2\%$.

[1] The exchange rate in our model moves with changes in the relative prices for traded and nontraded goods in the domestic market. So the exchange rate is not fixed.

The model economy is also forced to reduce profits of the representative firms, in the aggregate by 3%. This number is based on the projection of the Federal government (Bundesregierung 2010).

Fiscal policy is an important aspect of the current crisis. We include the following elements into our scenario: (i) the overall debt burden increases from 2007 to 2011 by 12.4% of GDP in 2011; (ii) net borrowing is allowed to rise up to 4.4% of GDP, (iii) government spending is up by 8.1%; (iv) pensions are raised by 9%; (v) average income tax rates are lowered so as to result in loss of tax revenue of 5%; (vi) social security contribution rates remain unchanged.[2]

One has to be clear about the fact that the results derived under these assumptions are only a snapshot of a development. By forcing the model to the forecast for 2011 we pretend somehow that this will be the new (steady state) equilibrium. That is obviously wrong. Our model will indicate, by construction, the need for further adjustments. Besides, we are not going to resolve these adjustment pressures. So, we actually use some information at a certain moment in time, without considering the long-term impact. The justification for this "cut-off approach" is merely informational. We believe that looking further into the future requires a true endogenous growth model, which includes genuine explanations of the drivers of growth. Such a modelling task is definitely beyond the scope of our work.

# 4 Results

Table 1 contains a number of key macroeconomic variables taken from the macroeconomic forecast (mainly from the Bundesbank) as well as our simulated allocation for "2011".

[2] Adjusting further fiscal parameteres is an interesting option to study the distributional effects of the crisis that will start to occur, once the government decides to restore fiscal sustainability.

| | change in % | |
|---|---|---|
| | forecast | simulation |
| GDP | -1,1 | -1,1 |
| Consumption | 2,1 | 0,4 |
| Investment | -4,0 | -4,6 |
| Government | 8,0 | 8,1 |
| Exports | -4,4 | -4,4 |
| Imports | 3,0 | 1,5 |
| Employment | -2,4 | -2,4 |
| Unemployment | 12,2 | 14,5 |
| Capital stock | | 4,7 |

Table 1: Forecasted and simulated changes in macroeconomic variables

A first conclusion from the exercise is that our CGE model is not able to precisely reproduce the macroeconomic forecast, but is qualitatively in line. With one major exception, which becomes clearer when we add the changes in wages (Table 2) to the picture. It is rather obvious that in a model with equilibrium unemployment an increase of both wages and unemployment is hard to reconcile. But that is what macro forecasters foresee. The Bundesbank expects real gross wages per worker to rise by 4.5%. Such a development may be due to slow and staggered adjustment processes, which are not built into our model. Besides, the model treats the benchmark allocation as a true equilibrium. A better fit of the stylised development could potentially be achieved if the benchmark is explicitly treated as an allocation off the steady-state growth path.

| | change in % |
|---|---|
| Employment | -2,40 |
| low-skilled | -3,09 |
| med-skilled | -2,76 |
| high-skilled | -0,02 |
| Gross Wages | -2,86 |
| low-skilled | -2,71 |
| med-skilled | -3,49 |
| high-skilled | -0,09 |

Table 2: Wage and employment effects per skill group

Apart from wages the model performs quite reasonable. The smaller rise in consumption is an obvious consequence of the drop in wages. Consumption stays only in black figures because pensions and other transfers rise significantly. We also expect capital income to fall further than projected, putting additional pressure on aggregate consumption. Lower rate of returns, however, result in less investment, an item that we approximate quite well.

Forecasted gross investments are an element of another forecasting result that raises a question. Basically all macro forecasts assume spending on structures and equipment to drop significantly. But at the same time, these forecasts assume the capital stock to grow (e. g. Bundesbank 2009: 27). An easy answer to this question would be foreign direct investment, but this appears not too plausible.

PACE-L is actually capable of reproducing these changes, because it does not link investments to the capital stock. The capital stock can adjust by capital imports and exports, while investment are the flipside of savings, which are modelled as in Ballard et al. (1985). So investment means the purchase of an aggregate of goods and services which is used in the production process, wherever this production takes place, at home or abroad.

In our model the labour force is assumed to be given and there is no change in labour supply behaviour.[3] So a drop in employment fully results in additional unemployment. This is the major reason why our model exhibits are stronger increase of unemployment than the forecast.

Turning to the employment and wage effects by skill group, our model seems to repeat a well-known result from the past. A good qualification saves you from the loss of employment and a cut of your wage. But this only holds for those workers with the highest qualification, comprising graduates from universities and other tertiary educational institutions. The biggest group, the medium-skilled workers, suffers similar losses than those without any formal qualification.

| | A_F | E_M | MAN | CST | T_T | B_I | Services |
|---|---|---|---|---|---|---|---|
| Gross Wages | | | | | | | |
| low-skilled | -2,49 | -2,01 | -2,61 | -1,99 | -3,76 | -2,34 | -2,39 |
| med-skilled | -3,25 | -2,87 | -3,82 | -3,11 | -3,52 | -3,54 | -3,24 |
| high-skilled | -0,09 | -0,09 | -0,09 | -0,09 | -0,09 | -0,09 | -0,09 |
| Employment | | | | | | | |
| low-skilled | -6,96 | -10,00 | -10,00 | -10,00 | 0,45 | -10,00 | 4,75 |
| med-skilled | -10,00 | -10,00 | -3,35 | -6,98 | -10,00 | -2,15 | 4,23 |
| high-skilled | 9,62 | -9,74 | -6,76 | -7,29 | -1,43 | -2,79 | 6,31 |

Table 3: Wage and employment effects by industry

A_F: Agriculture and Fishery; E_M: Energy and Mining; MAN: Manufacturing; CST: Construction; T_T: Transport and Trade; B_I: Banking and Insurance; Services: all other services

A look at the distribution of the wage and employment changes by industry (Table 3) reveals that the employment changes diverge much more than the wage changes. So although employment increases considerably in the service sector − comprising all services apart from trade and transport (T_T) and banking and insurance (B_I) − wages fall even there. For the high-skilled workers the explanation for this is straightforward, since we assume that their services are traded on one

[3] This is an issue that could be explored in the future with the help of our behavioural microsimulation model .

market. For the other skill types wages are sector-specific. These wages are a function of profits, output, other factor prices, and sectoral unemployment.

An important feature of PACE-L in the current version is the equalization of sectoral unemployment rates. This appears a reasonable result, if we expect laid-off workers to be relatively mobile between industries. This sort of flexibility avoids wages from drifting apart. Put differently, our model does not show much insider power in wage-bargaining. A feature that is certainly questionable.

Since we do not use the change in employment at this stage, the sectoral information is not very important. That is not very convincing, since we would expect rather marked differences between expanding and contracting sectors.

# 5 Distributional effects

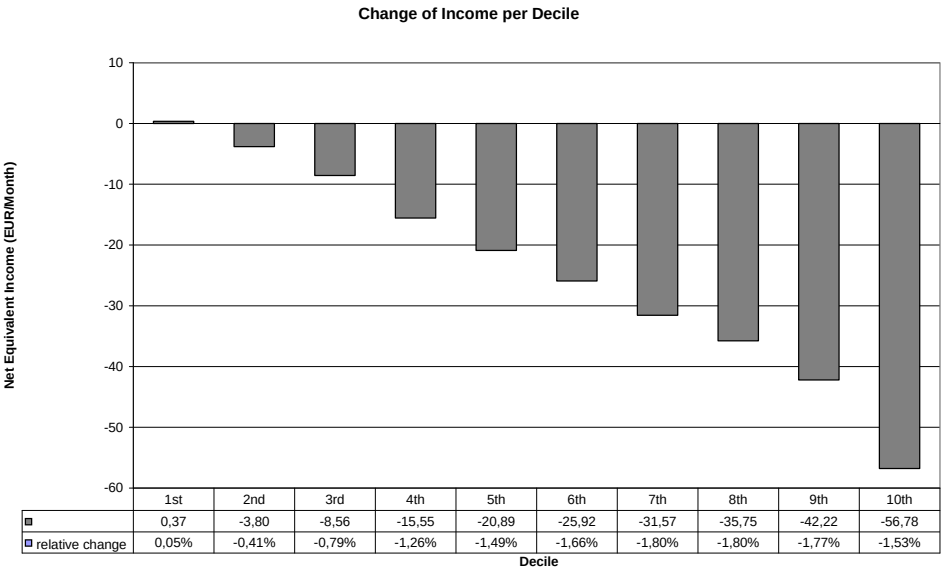
We now feed the wage effects, which we computed in the CGE model, into a microsimulation model. This model was build in order to estimate the labour supply effects of changes in taxes and transfers. In its full mode it is a behavioural microsimulation model. Here, we only use the tax-benefit part of it. We also abstract for the moment from changes in the tax and transfer legislation that might be linked to the economic crisis. In other words, we presume that the tax and social code is the same in the benchmark as well as in the counterfactual. That assumption allows the computation of a pure gross wage effect. A next step would be to include comparable changes of the tax and benefit parameters in both models.

The microsimulation model uses data from the GSOEP, an annual household survey covering about 12.000 households with more than 20.000 adult persons sampled. The data source is acknowledged as quite good with respect to the measurement of wages (see e.g. Jacobebbinghaus 2002) and employment. This does not hold to the same extent for other sources of income and also not for the distribution of assets,

a problem that the GSOEP shares with many other similar surveys. The microsimulation model has been in use in different versions for about 10 years. Recently it was used to assess a proposal to reform in-work benefits in Germany (Bruckmeier and Wiemers 2008).

The standard approach to detect changes in the income distribution is the comparison of inequality measures of two allocations. Following this path leaves us without much insight. The changes are so small that they can't be interpreted as significantly different.

Looking at the average changes of net equivalent incomes per decile, reveals a little bit more. The first decile is basically exempt from the changes in factor prices, because these households rely almost exclusively on public transfers. Where there are losses of income they are compensated by increases in benefits. The second decile displays a mixture of people also "sheltered" from the adverse wage growth and others who are hit by lower salaries. In the 3rd and 4th deciles there is gradual increase of the wage effects. From the 5th decile onwards the income losses are roughly proportional.




| | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0,37 | -3,80 | -8,56 | -15,55 | -20,89 | -25,92 | -31,57 | -35,75 | -42,22 | -56,78 |
| relative change | 0,05% | -0,41% | -0,79% | -1,26% | -1,49% | -1,66% | -1,80% | -1,80% | -1,77% | -1,53% |

Changes in the personal income distribution

This is somewhat surprising since high-wage earners virtually suffer no negative net wage effect. However, at the upper end of the income distribution the importance of capital income (interest, dividends, etc.) rises. Since the remuneration of capital falls distinctively further than those of labour, wealthier households lose relatively more than those in the middle of the distribution. This result is not monotone, though.

# 6 Conclusions

The research project outlined in the introduction remains currently unfinished. While we were able to come up with a simulation for industry-specific wages and employment that is roughly in line with macroeconomic forecasts a number of tasks await their completion and a few unsolved methodological issues remain.

A first point to be mentioned is the lack of consistency between forecast and simulation that arises with respect to average change of wages. While a macroeconomic model might be able to produce temporary allocations that contradict mainstream economics, this can hardly be done with an applied general equilibrium that is rooted in the general equilibrium world of Arrow and Debreu. The unreconciled wage evolvement highlights the general question of the usefulness of a GE approach in our context. The GE model finally forces prices to adjust to their equilibrium values. An important extension of the current set-up should progress towards approaches like Dixon and Rimmer's (2007), where wages cannot adjust immediately. A solid modelling of the wage behaviour then requires knowledge about the stickiness of wages, an unresolved issue in the macroeconomics literature.

Secondly, even if we manage to improve the macro part considerably, the question remains whether the idea of feeding information into the microsimulation part is a good one. Maybe the top-down approach is inferior to the other way round. It would definitely be of great help, if we knew more about individual wage changes

and the transitions from employment to unemployment due to the crisis. That holds in particular, if we seriously take up the task of picking job losers.

Without the analysis of who becomes unemployed, the distributional analysis remains incomplete. While for Germany this caveat can be downplayed a little bit, since employment reactions are still stunningly small, it is absolutely necessary in the analysis of economies that have experienced dramatic increases in unemployment such as Spain or the US.

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