

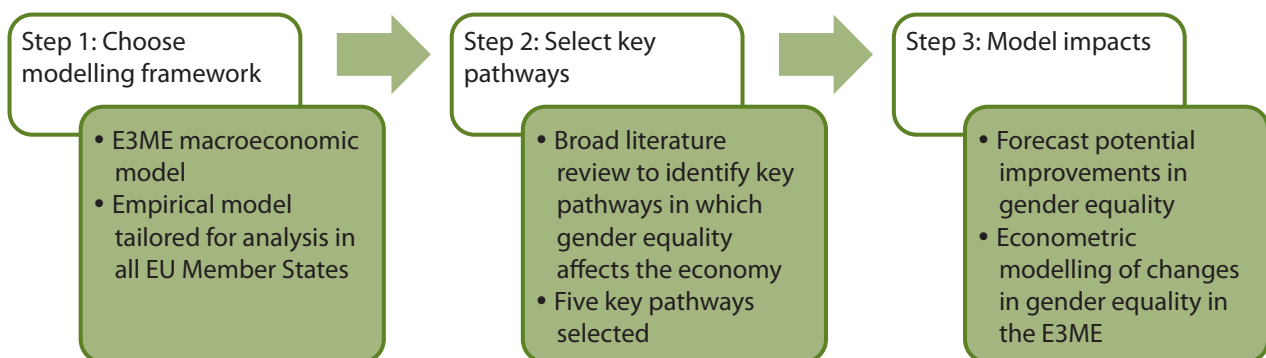
1. Introduction

The study on the economic benefits of gender equality is unique in the EU context. It is the first of its kind to use a robust econometric model to estimate a broad range of macroeconomic benefits of gender equality in several broad policy areas such as education, labour market activity and wages. It also considers the demographic consequences of such improvements. There is no previous

study that has attempted econometric modelling of such a broad range of impacts of gender equality in the EU.

The methodological approach of this study involved three key steps, as shown in Figure 1.1.

Figure 1.1. Key methodological steps



Step 1: Choosing the macroeconomic modelling framework

This study uses the E3ME macroeconomic model to estimate the economic impacts of improvements in gender equality. E3ME is an empirical macroeconomic model tailored specifically to model outcomes at EU and Member-State levels. The model includes a detailed representation of the labour market and captures interactions at sectoral and national levels. It is a model widely acknowledged as suitable for modelling economic trends at EU

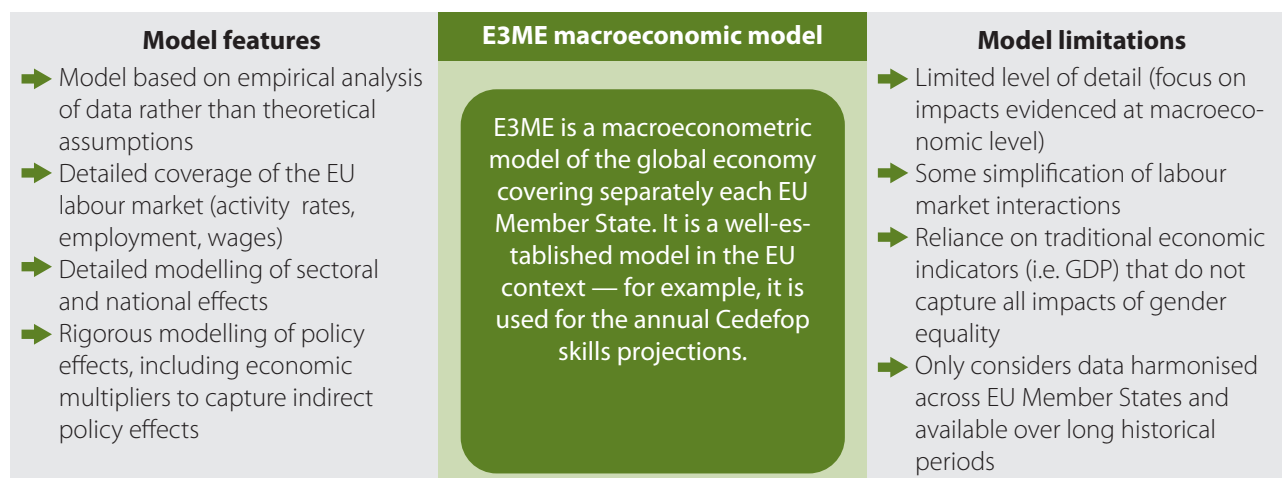
level — for example, Cedefop uses this model for its skills forecasts.

However, the nature of the E3ME model only allows for modelling impacts of improved gender equality that are robustly evidenced at macroeconomic level. Impacts documented only through microeconomic or qualitative research are therefore excluded from modelling.

The key features and limitations of the E3ME modelling framework are summarised in Figure 1.2.



Figure 1.2. E3ME modelling framework



Step 2: Selecting pathways through which gender equality affects the economy

This study models the social and economic impacts of the following five main pathways/outcomes⁽¹⁾ that were identified to have significant macroeconomic impacts at EU level.

- Pathway 1: Close the gender gap in tertiary education.
- Pathway 2: Close the gender gap in labour market activity.
- Pathway 3: Close the gender pay gap.
- Outcome 4: Demographic change due to the closing of gender gaps.
- Pathway 5: Combined effects of pathways 1 to 3 and outcome 4.

An extensive literature review was carried out to identify a broad range of social and economic impacts of gender equality. These impacts were then discussed with a forum of independent experts to select impacts that could be modelled at macroeconomic level. The pathways modelled in this study were selected based on these discussions, following three main selection criteria, as listed below.

- Robust evidence of pathway impact at macroeconomic level.

- Comparable historical and empirical data are available to model the impact at EU level.

- The pathway captures important gender inequalities apparent at EU level.

Step 3: Modelling the economic impacts of pathways

The first step was to develop a forecast of potential improvements in gender equality in labour market activity, education participation and wages. A forecast of demographic changes resulting from such improvements was also developed, reflecting evidence that higher gender equality tends to increase fertility rates. These forecasts were based on a detailed analysis of potential impacts that could arise after adopting new gender equality measures across the modelled pathways.

The analysed pathways result in improvements to the situation of women, because they focus on areas where women face substantial disadvantages. In all pathways structural changes are required, and it is assumed that women would also change their behaviour (e.g. by asking for pay rises) in order to reduce gender gaps. It is not assumed that these gaps will be completely eliminated — rather, the lowest gender gaps identified across the EU Member States are used as a threshold of change.

⁽¹⁾ The term 'pathway' refers to a certain gender inequality, for which at least a theoretical link to macroeconomic performance has been established in literature. The term 'outcome' refers to potential consequences of gender equality (i.e. change in fertility) that can affect the performance of the economy.

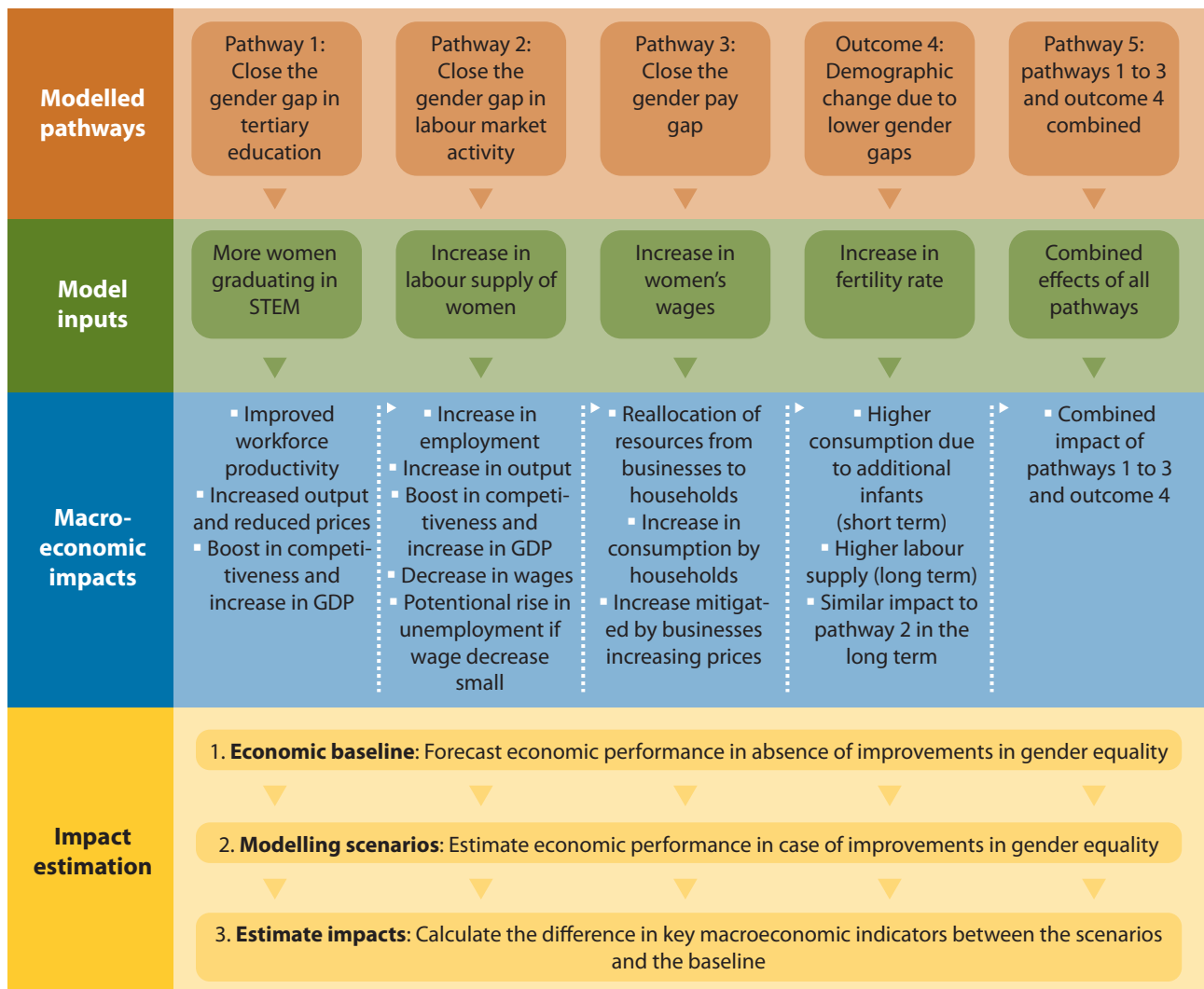
These forecasts were put into the E3ME model to assess the wider socioeconomic impacts of gender equality on GDP, employment and other important economic indicators. The forecasts were put into the model separately for each pathway or outcome to allow the socioeconomic impacts of each individual pathway or outcome to be estimated and to avoid double counting. The cumulative effects of combined pathways 1 to 3 and outcome 4 were also modelled to provide a comprehensive estimate of economic impacts across all pathways and to analyse their possible interactions.

The impacts were estimated by comparing future economic performance based on historical trends (baseline

case) with scenarios that forecast improvements in gender equality. The modelling approach had the following three steps.

1. Model the economic baseline to forecast economic performance in the absence of improvements in gender equality.
2. Model the scenarios to estimate economic performance when improvements in gender equality occur.
3. Estimate impacts as the difference in key macroeconomic indicators between the scenarios and the baseline.

Figure 1.3. Approach to modelling macroeconomic impacts of gender equality





2. The modelling framework

2.1. Introduction to the E3ME model

E3ME is a macroeconomic model with a detailed representation of the EU and global labour markets. It features econometrically estimated equations for labour market participation, employment and wage rates at sectoral and regional levels. It is a demand-driven model which considers both the direct policy impacts and their subsequent influence on the whole economy, including economic multipliers of the policy effects ^(?).

The model provides a consistent framework for the gender equality analysis ^(?) because:

- unlike many other macroeconomic models, E3ME allows for labour markets to be out of equilibrium and includes involuntary unemployment or economic inactivity;
- persistent labour market imbalances related to gender inequality can feature in the model's results, even if they are not rational from an economic point of view.

The model does not assume that economic agents are fully rational and optimise their decisions, or that firms are necessarily maximising profit. Instead of relying on agent optimisation assumptions, E3ME simulates the actions of economic agents based on empirically observed behaviours. There is a growing field of economic literature that regards such empirically driven approaches as a more adequate representation of complex real-world behaviour (Beinhocker, 2007; Kahneman, 2011).

The model consists of various econometric equations, each using a data set of annual time series that date back to 1970; the results from the estimation include standard measures of fit and tests for significance. However, instead of using standard t-tests to justify inclusion of explanatory variables in the model based on their statistical significance, the Akaike Information Criterion (AIC) is used to select the equation specification that best fits and explains the historical data. In some cases, for example where data series are short or incomplete, shrinkage estimation is used or an alternative, simpler model specification is applied ⁽⁴⁾. It is possible to assess formally the robustness of each individual econometric equation in the model, for example by constructing confidence intervals. It is also possible to test how well the equations explain the historical data ⁽⁵⁾. However, there is no equivalent method for estimating robustness or explanatory power of the modelling system as a whole — i.e. how well the equations fit together.

2.2. E3ME model structure and economic flows

Figure 2.1 highlights the key macroeconomic linkages within the E3ME model. The main paths of causality are as follows.

- As an immediate consequence of the higher number of women active in the labour market, the labour supply will increase. There is likely to be an initial excess in labour supply, which will put downwards pressure on wages and potentially lead to some immediate increase in unemployment. Over time, wage rates will decline and, eventually, employers

(?) An economic multiplier is the factor by which gains in total output are greater than the change in spending induced by a policy. The size of the multiplier varies by region and sector according to empirically estimated relationships, including supply-side constraints like the pool of unemployed labour. The GDP multiplier in E3ME is typically in the range of 1.5 to 2.

(?) However, as the E3ME is an economic model based on the national accounting system it does not capture things that are not included in GDP. Some examples of dimensions that the literature on gender economics has highlighted as important, but that the E3ME model will not be able to cover, are listed below.

- Not including unpaid household work, which can account for as much as a third to a half of GDP (Miranda, 2011).
- Not including the costs of reproduction of labour, which neglects the importance of unpaid domestic and care work for reproduction of societies (Picchio, 1992).
- Focusing on gender equality as equality in resources rather than equality in opportunities in the well-being domain (Sen, 1992).
- Treating the household as a unique entity and thus neglecting the issues of household bargaining (Agarwal, 1997).

(4) A simpler model specification might, for example, assume that consumption grows in line with real incomes, or that employment in a particular sector grows in line with gross output in that sector after an adjustment to take account of a fixed labour productivity expectation.

(5) The R² value is a measure of how well the estimated equation explains variation in the data. Most of the econometric equations that are used for EU Member States have high explanatory power. For example, the average adjusted R² value for the consumption equations (by EU Member States) is over 92 % in the long term. The equations in E3ME use time-series data, where R² values are typically high (90 % or higher) as they pick up trends in the historical data. Adjusted R² is used to adjust for the number of parameters in the model, as the R² value increases with the number of parameters included.

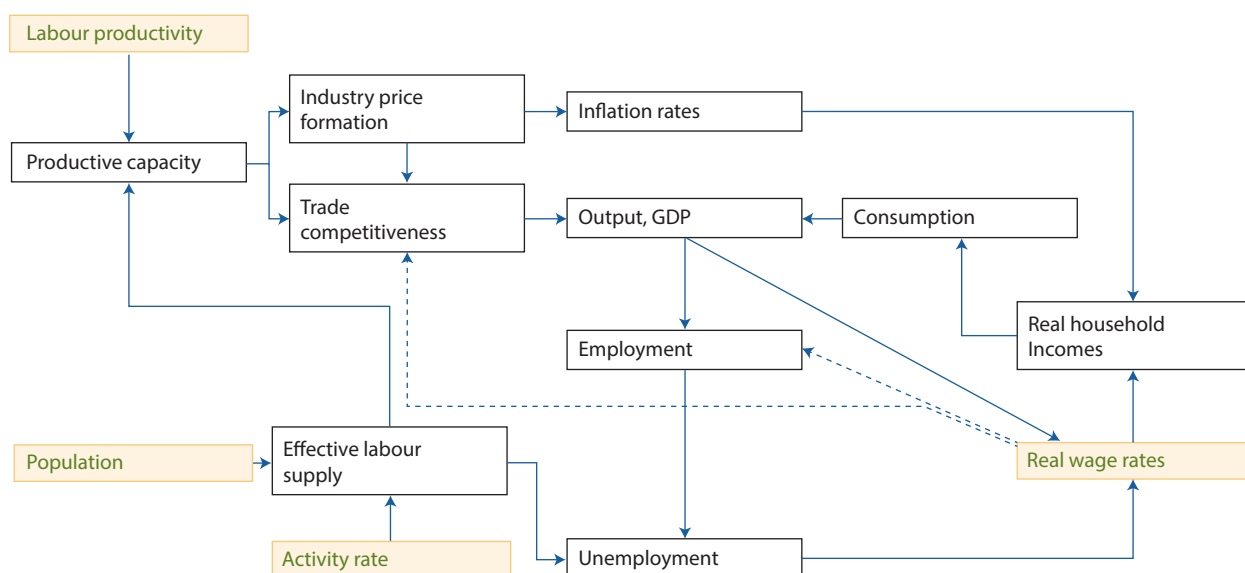
will start hiring more workers because of the lower wage rates. At macroeconomic level, a larger workforce leads to an increase in potential output ⁽⁹⁾, which is likely to motivate firms to reduce prices. An increase in the supply of labour will also enable sectors that were previously labour constrained (e.g. due to a shortage of skilled workers) to increase output. Overall, lower relative wage rates will improve the competitiveness of EU firms and, in the long run, increases in output are likely to lead to higher employment levels, negating the initial increase in unemployment.

- An increase in the number of women with STEM (science, technology, engineering and mathematics) qualifications will also increase potential output in certain industry sectors. This is because educational improvements will lead to a more productive workforce and output per worker will increase. This increase in labour productivity will allow firms in these sectors to increase output and reduce average prices for their output. According to economic theory and historical observation, the likely outcomes

following an increase in economic output and lower prices are increases in domestic real incomes and a boost to competitiveness, both of which will lead to higher GDP.

- Higher wage rates for women represent a reallocation of resources from business to households. The net effects may be either positive or negative, depending on how households spend their additional income and how companies react. An increase in consumption seems likely but initial benefits could be cancelled out if companies increase prices in response.
- Fertility-rate increases due to higher gender equality and will result in larger population. In the short run this will lead to higher consumption due to the additional infants (not shown on the diagram), although consumption per capita would be likely to fall. Once the additional people reach working age, labour supply could increase. This leads to the same effects as described in the first bullet point above.

Figure 2.1. Key flows and interlinkages in E3ME when modelling labour market scenarios



NB: The yellow boxes highlight model inputs (exogenous variables to be input into the model); the other variables are projected based on the model equations (endogenous variables).

⁽⁹⁾ Potential output, or the potential productive capacity of the economy, refers to the maximum economic output when all resources are fully utilised. Increases in the size of the labour force means that there is a larger pool of workers to draw upon and, therefore, there is potential to produce much more.



2.3. Limitations of the modelling framework

All modelling approaches represent simplifications of reality and E3ME is no exception. It is important to be aware of the underlying limitations in modelling in order to correctly interpret its results. The main limitations of the modelling framework used in this study are as follows.

- E3ME is a highly empirical macroeconomic model incorporating econometric estimates based on historical data to estimate future behaviour. As such, it has sometimes been criticised by proponents of modelling approaches based on assumptions derived from economic theory rather than historical analysis of data (?).
- The model relies solely on macroeconomic indicators, which precludes modelling of the social and economic impacts of some aspects of gender equality documented at microeconomic level (such as impacts of women's leadership on businesses).
- A more practical limitation in the modelling is the level of detail possible. While E3ME considers interactions at

sectoral level, the level of detail is limited to sectoral divisions based on NACE two-digit level.

- While E3ME includes a detailed treatment of gender in the labour market (labour supply and employment equations are estimated separately for men and women), there are some simplifications in representing labour market interactions. The model estimates how increases in labour supply affect different sectors based on historical data, but does not directly represent the labour force by occupation or by skill level. As such, the model may not take account of the full range of potential skill shortages in some sectors of the economy. It is also not possible to differentiate productivity by sex.
- The final limitation in the modelling approach relates to the data requirements of the model. Most of the E3ME data are sourced from Eurostat (for EU Member States), which provides consistency across Member States, but previous revisions to published data have shown that there is some uncertainty in the information held in the model's historical databases.

3. Selection of pathways suitable for macroeconomic modelling

A range of research activities was carried out to identify pathways through which gender equality can influence the economy and select those that were suitable for macroeconomic modelling.

- Initially, an extensive literature review was carried out to identify a broad range of socioeconomic impacts of gender equality. This review covered literature at both EU and national levels in order to capture all relevant evidence and to reflect the potential diversity of impacts across EU Member States. It covered more than 300 research publications that (at least partially) focused on the social and economic impact of gender equality.

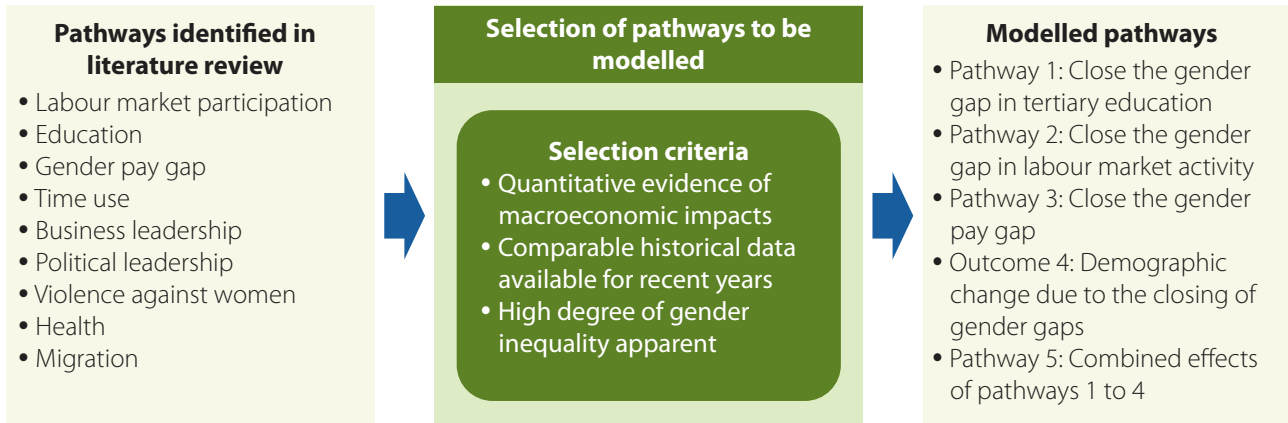
- The literature review indicated that there were nine main pathways through which gender equality can affect the economy (see Figure 3.1). For each of these pathways the research team developed a detailed map of potential ways in which gender equality influences the economy and proposed potential approaches to modelling such impacts.
- The nine pathways were then presented to a forum of international experts in gender equality and economics, to gather feedback and refine the modelling approach.

(?) For example, the E3ME modelling in this study is subject to limitations related to the 'Lucas Critique' because it considers changes in policy as well as potential changes in technology that may lead to behaviour that is different from historical estimates.

- Based on the feedback, five pathways/outcomes were selected as relevant for macroeconomic modelling in the E3ME model. Other pathways were excluded from modelling, mainly because:
 - they were not likely to have a sufficiently large impact to be registered at a macroeconomic scale; and
 - there was insufficient evidence/data on their economic impacts at macroeconomic level.

The rest of this section presents a brief rationale for including each of the selected pathways/outcomes in the macroeconomic modelling, including the evidence of underlying gender inequalities and their potential impacts on the economy.

Figure 3.1. Pathway selection



3.1. Closing the gender gap in tertiary education (pathway 1)

While in most Member States young women are better educated and have higher enrolment rates to tertiary education than young men ⁽⁸⁾, significant inequalities between boys and girls persist in certain specific fields of education.

Namely, girls are less likely than boys to choose STEM as a field of study at graduate and postgraduate level than boys, even when they perform at a comparable level in maths and science (European Parliament, 2015). The available literature (OECD, 2011; Sikora and Pokropek, 2011) often attributes this to gender stereotypes in education and training and a lack of female role models in STEM.

At individual level, lower participation of women in STEM studies may translate into lower employment prospects, lower earnings in the labour market and, subsequently, lower economic independence. This is because STEM-related sectors have been growing much faster

than others and have significantly higher wages (European Parliament, 2015).

At aggregate level, such differences have potentially significant implications for employment, productivity and economic growth. Reducing the gender gap in STEM education areas could help reduce bottlenecks in the labour market, increase the employment and productivity of women and reduce occupational segregation. Ultimately this could foster economic growth via both higher productivity and increased labour market activity (European Commission, 2014).

3.2. Closing the gender gap in labour market activity (pathway 2)

It is probably in the labour market that differences between women and men are most marked in the EU. Women are less active in the labour market (by about 15 % ⁽⁹⁾) and are often forced to pursue lower career profiles. This typically results from women undertaking much more unpaid work than men, including caring obligations for children and elderly relatives.

⁽⁸⁾ According to Eurostat data in 2015, 28.2% of the EU's female population from the 15 to 64 age bracket had a tertiary education degree while the same proportion for males was 24.7%. At the Member State level only two out of 28 countries, namely Germany and Austria, had a lower proportion of women with a tertiary degree than men.

⁽⁹⁾ Based on 2014 Eurostat data on labour market activity rates.



Starting from the ‘womenomics’ theory proposed by Matsui et al. (1999), several studies have assessed that increasing the participation of women in the labour market is likely to increase GDP and counterbalance the negative effect of the ageing population in developed countries. According to research led by the OECD (2008), narrowing the gap between employment rates of men and women has accounted for half of the increase in the EU’s overall employment rate and a quarter of annual economic growth since 1995.

The importance of increasing the labour market participation of women for GDP growth is assessed by multiple international studies. Daly (2007), Löfström (2009) and Aguirre et al. (2012) show that increasing gender balance in labour market participation and employment would significantly increase GDP in the EU. Similar results are confirmed at national level (Casarico and Profeta, 2007; Matsui et al., 1999, 2005, 2010, 2014; Bryant et al., 2004; Klasen, 1999; Klasen and Lamanna, 2009; Mitra et al., 2015; Esteve-Volart, 2009; Cuberes and Teignier, 2012, 2016; Loko and Diouf, 2009). These studies generally agree on the positive macroeconomic impact of increasing the labour market activity of women.

3.3. Closing the gender pay gap (pathway 3)

In spite of EU legislation aimed at securing equal pay for women and men — ‘Equal pay for equal work’ is one of the European Union’s founding principles — the gender pay gap has persisted in the 21st century. In 2014, gross hourly earnings of women were on average 16.1 % below those of men in the European Union ⁽¹⁰⁾, with high variability across Member States.

Equal-pay legislation, technological changes ⁽¹¹⁾ and evolving social norms contribute, among other factors, to reducing the gender pay gap (Olivetti and Petrongolo, 2016). However, gender differences in pay still persist in all EU Member States. Different authors (Bertrand et al., 2014; Goldin and Katz, 2002 (among others)) have shown that one of the main drivers of the gender pay gap is women’s dominant role in the provision of childcare and home production in general and the consequent work–life balance considerations. Further explanations of the

persisting gender pay gap come from the psychological and experimental literature. According to these findings women are more risk averse than men (Croson and Gneezy, 2009), less likely to opt for performance pay (Niederle and Vesterlund, 2007) and less likely to negotiate for their wages (Babcock et al. 2003, Rigdon, 2013).

While the findings from research on the economic consequences of reducing the gender pay gap are more ambiguous than in other pathways, some studies find a positive impact of reducing gender pay gap on GDP and income per capita (Schober and Winter-Ebmer, 2009; Tzannatos, 1999; Cavalcanti and Tavres, 2008), on savings and investments (Seguino and Floro, 2003; Rossi and Sierminska, 2015; Ward et al., 2010; World Bank, 2012) and on women’s confidence and responsibility at work (Booth, 2003; Fernandez, 2014).

3.4. Demographic change due to the closing of gender gaps (outcome 4)

Apart from economic impacts resulting directly from changes in women’s education, employment and income, there is a wealth of literature that evidences the impacts of such changes on women’s fertility. These impacts are particularly important in the EU context, given the potential negative consequences of current demographic trends for economic growth in the EU (Bloom et al., 2010). Indeed, facilitating the materialisation of intentions and consequently rising fertility rates has increasingly been perceived as an important goal for EU policy, with important economic consequences.

In recent years fertility has increased, particularly in the most developed societies with a high degree of gender equality ⁽¹²⁾. In line with these trends, recent research has been providing an increasing amount of evidence that greater gender equality in employment, economic resources and a more equal distribution of unpaid care work tends to lead to increases in fertility in developed countries (Begall and Mills, 2011; Vignoli et al., 2012; Mills et al., 2008; Mills, 2010; Esping-Andersen et al., 2007; McDonald, 2000a, 2000b; Brewster and Rindfuss, 2000; Ahn and Mira, 2002; Engelhardt, Kögel and Prskawetz, 2004; Castles, 2003; Mencarini and Tanturri, 2004; Puur et al., 2008).

⁽¹⁰⁾ http://ec.europa.eu/eurostat/statistics-explained/index.php/Gender_pay_gap_statistics

⁽¹¹⁾ Technological progress in the workplace has raised the value of non-manual skills relative to manual ones, thereby raising female relative wages (Black and Spitz-Oener, 2010).

⁽¹²⁾ Based on comparison of Eurostat data on fertility rates and ranking in EIGE’s Gender Equality Index.

Improved gender equality has also been linked to increases in fertility rates in the EU. More specifically, higher fertility rates have been attributed to an increase in the employment of women, to an increase in women's incomes, to better care support for children and other dependants, to gender-sensitive family support policies and to changes in sociocultural attitudes towards working mothers and the gender roles of parents (Neyer et al., 2013; Matysiak and Vignoli, 2008).

To summarise, it is likely that the closing of gender gaps in education and the labour market will have a positive influence on fertility, with important economic consequences for the EU. However, there is currently insufficient evidence to establish the exact impact of inequalities in education, pay and employment on fertility. We therefore model fertility impacts separately as outcome 4, rather than as part of the pathways corresponding to these inequalities.

4. Modelling selected impacts of improvements in gender equality

To explore the impact of gender equality measures on the labour market and the wider economy, specific modelling scenarios were developed for each of the selected pathways/outcomes. In total, 11 scenarios were modelled at the EU and Member State levels, forecasting different paths of economic development until 2050 based on the progress achieved in eliminating gender inequality⁽¹³⁾.

- The baseline scenario forecasted economic development assuming that no additional improvements in gender equality will be achieved beyond what could be expected based on recent historical trends.
- The 'slow-progress' scenarios assumed some additional, gradual improvement in gender equality compared to the baseline. Five slow-progress scenarios were developed, one for each pathway.
- The 'rapid-progress' scenarios assumed considerable, swift additional improvement in gender equality compared to the baseline. Five rapid-progress scenarios were developed, one for each pathway.

To assess the macroeconomic impacts of each pathway/outcome we compared forecasted development under the progress scenarios associated with that pathway/outcome against the baseline. This established what the socioeconomic impact of improvements in gender equality over the 2016 to 2050 period would be. The results of this analysis are presented as a percentage and/or an absolute difference from the baseline.

The use of slow- and rapid-progress scenarios reflects the relatively sparse evidence of macroeconomic impacts of broad improvements in gender equality. In the absence of more robust impact evidence we prefer providing high and low estimates of gender equality impacts rather than one 'true' estimate.

The remainder of this section provides more detail on the development of the baseline and progress scenarios.

⁽¹³⁾ Note that improvements in gender equality were assumed to be achieved by 2030. The modelling period was extended to 2050 in order to capture the more long-term impacts of the achieved changes.



4.1. The baseline scenario

An important part of the scenario analysis involves forming a credible baseline describing the expected development of the EU labour market and economy under current policy and regulation. By defining the labour market conditions at Member State level, the choice of baseline can have a large bearing on the socioeconomic impacts of the progress scenarios. For example, if there is excess labour supply and high unemployment in the baseline then a policy that increases labour demand is likely to have a limited impact on wages and prices compared to an alternative baseline in which the labour market operates close to full employment.

It is important to use a robust, credible baseline that does not introduce bias into the progress scenario results. For this reason the E3ME baseline is made to be consistent with forecasts used in other analysis and official European Commission publications.

- The baseline used in this analysis has been made consistent with the latest labour market projections published by Cedefop (2016) ⁽¹⁴⁾. For its employment forecasts Cedefop uses a version of the E3ME model combined with detailed off-model estimates of employment demand and supply. The main results used here are the projections of labour supply and employment by economic sector. The projections are verified at Member State level by a group of national experts and are modified to take into account the feedback that these experts provide.
- Demographic trends are consistent with the Eurostat population projections (Europop, 2013) ⁽¹⁵⁾ — these projections also include changes in population due to migration, which are therefore reflected in our baseline. As gender equality measures could affect fertility rates, it is particularly important to appreciate the demographic trends and, specifically, the fertility rate trends that are already reflected in the Europop baseline.
- Other economic projections are made consistent with *The 2015 ageing report* (DG Economic and Financial Affairs, 2014) and the underlying assumptions in the publication *Trends to 2050* (DG Energy, 2013).

4.2. Progress scenarios

Separate progress scenarios were developed for each of the selected pathways/outcomes (and their combinations) to allow for empirical testing of the economic impacts of gender equality. This required the detailed analysis of historical data to identify past trends in gender equality, the development of suitable approaches to projecting these trends into the future and the review of additional literature to better understand the likely future impact of the projected trends. Simultaneously to the development of the modelling scenarios, the E3ME model was tailored to better capture gender equality issues, reflecting the comments of independent experts on our modelling approach.

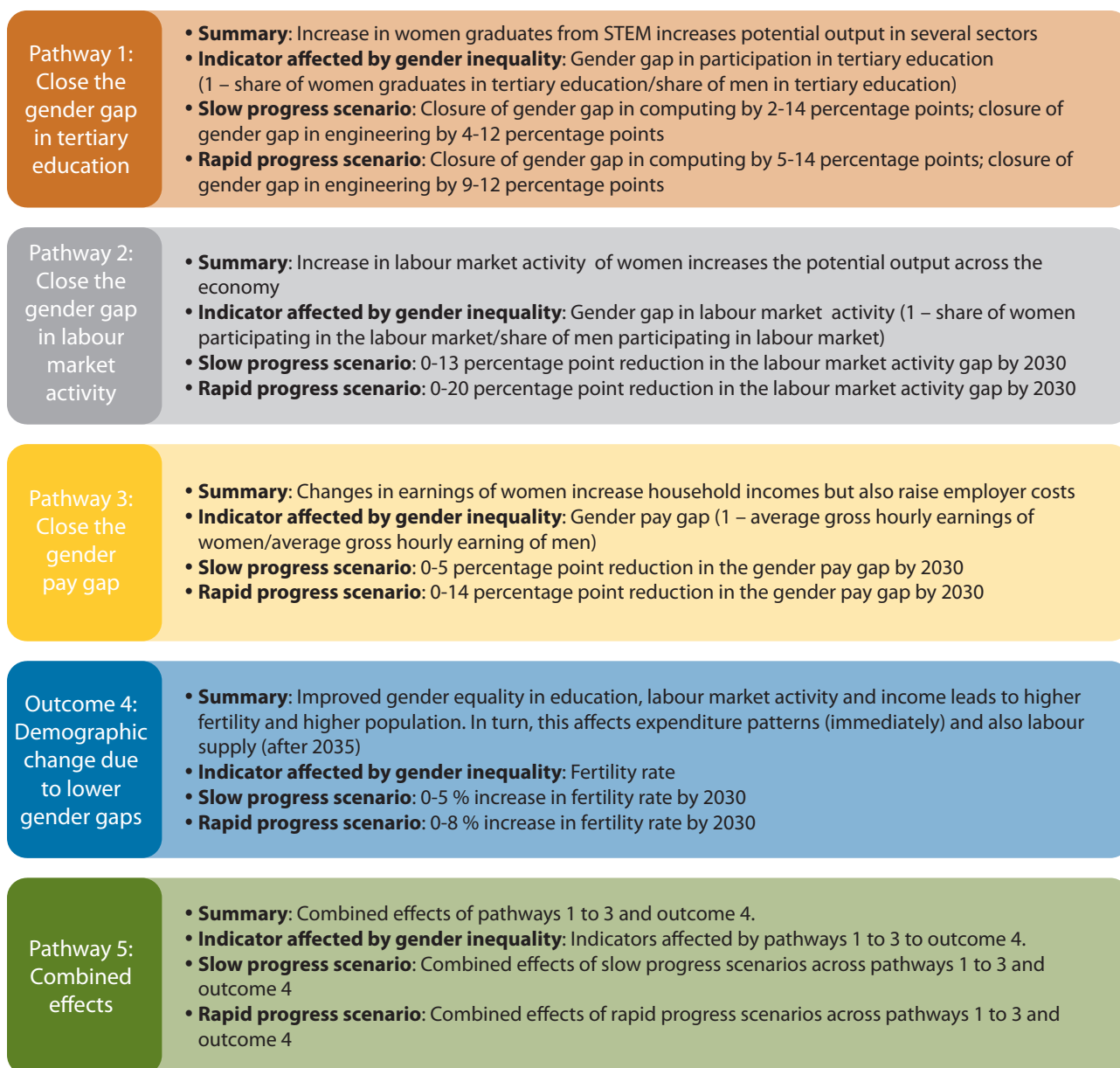
The impacts of gender equality are assumed to result from additional gender equality measures adopted by the government (and potentially also other actors). For each pathway, measures that could help improve gender equality are discussed. However, this study primarily focuses on estimating the economic impacts of improvements in gender equality, rather than on the exact ways in which such improvements can be achieved. It is beyond the scope of this study to identify the exact policy combinations necessary to improve gender equality and their likely costs to the government. The estimates of gender equality impacts presented throughout this study should therefore be interpreted as an upper bound, as they do not include the direct policy costs of gender equality measures to the government.

Throughout the rest of this section, the slow- and rapid-progress scenarios are presented for each of the modelled pathways/outcomes. The figure below provides a brief overview of the progress scenarios for each of the pathways/outcomes.

⁽¹⁴⁾ <http://www.cedefop.europa.eu/en/events-and-projects/projects/forecasting-skill-demand-and-supply/data-visualisations>

⁽¹⁵⁾ <http://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data>

Figure 4.1. Summary of progress scenarios



4.2.1. Closing the gender gap in tertiary education (pathway 1)

This pathway estimates the potential change in the gender education gap by 2030 compared to the baseline. This change could result from future gender equality measures (i.e. removal of stereotypes in education; promotion, awareness raising and career guidance to encourage girls to study in male-dominated fields and boys in female-dominated fields) that could take place in addition to the baseline scenario.

The gender education gap is defined as:

$$Gap_{edu} = \left(1 - \frac{Share_w}{Share_M} \right)$$

where $Share_w$ stands for the proportion of women graduates in the total number of graduates and $Share_m$ stands for the corresponding proportion of men graduates. Note that if Gap_{edu} equals 1 the educational field is completely dominated by men; if it is 0 there is an equal share of men and women; and if it is negative there are more women than men among graduates.

The pathway focuses on gender gaps in the fields of computing and engineering. These education fields are marked by low student participation of women compared to men, despite strong employment prospects after finishing studies. Other educational fields (such as humanities, social sciences or business studies) are not considered in this pathway, either because of their low



employment prospects or because no clear-cut evidence of gender inequality in participation was identified.

The estimates of the future potential decrease in gender gaps in education have been prepared for computing and engineering trade fields separately. The potential for

closing the gender education gap in Member States was estimated based on the historical rate of reduction of the gender gap in education over the period between 2001 and 2013. The key assumptions used in this estimation are summarised in Box 4.1 below.

Box 4.1. Key modelling assumptions for pathway 1

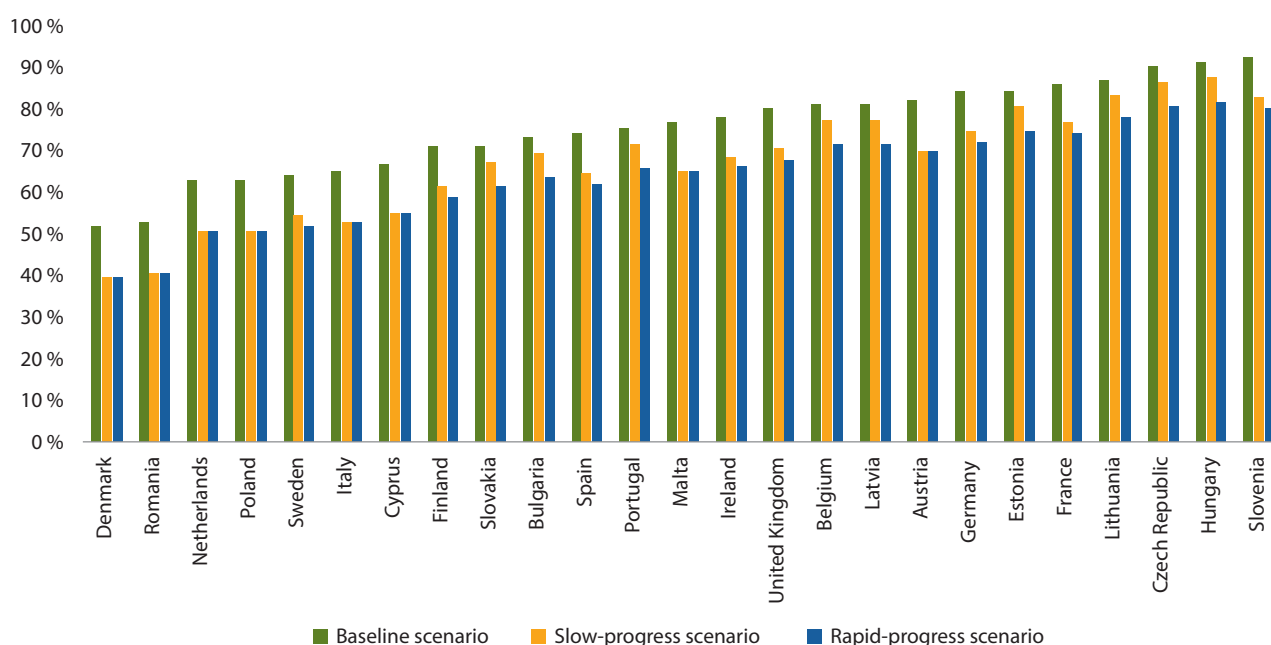
1. **Gender equality can be improved in all Member States** because of sizeable gender gaps in STEM education.
2. **Prior historical trends are an indicator of potential future improvements in gender equality.** This is a conservative assumption based on the fact that prior negative historical trends are likely to result from a variety of factors (i.e. cultural attitudes towards gender equality) which can inhibit policy impact.
3. **The education gap can be closed by an increase in the number of women graduating in STEM subjects** rather than a decrease in the number of male graduates. This is because of high demand for STEM students in the EU labour market (European Parliament, 2015), often resulting in skill shortages in this area.

Although E3ME includes a basic measure of educational attainment, it does not include detail by subject area. To model this scenario in E3ME we therefore used information on the total share of STEM graduates by sector to estimate the extent to which an increase in STEM graduates would boost the potential productive capacity at sectoral level. This means that the increase in potential

productive capacity will be largest in those sectors that employ a relatively high share of STEM graduates.

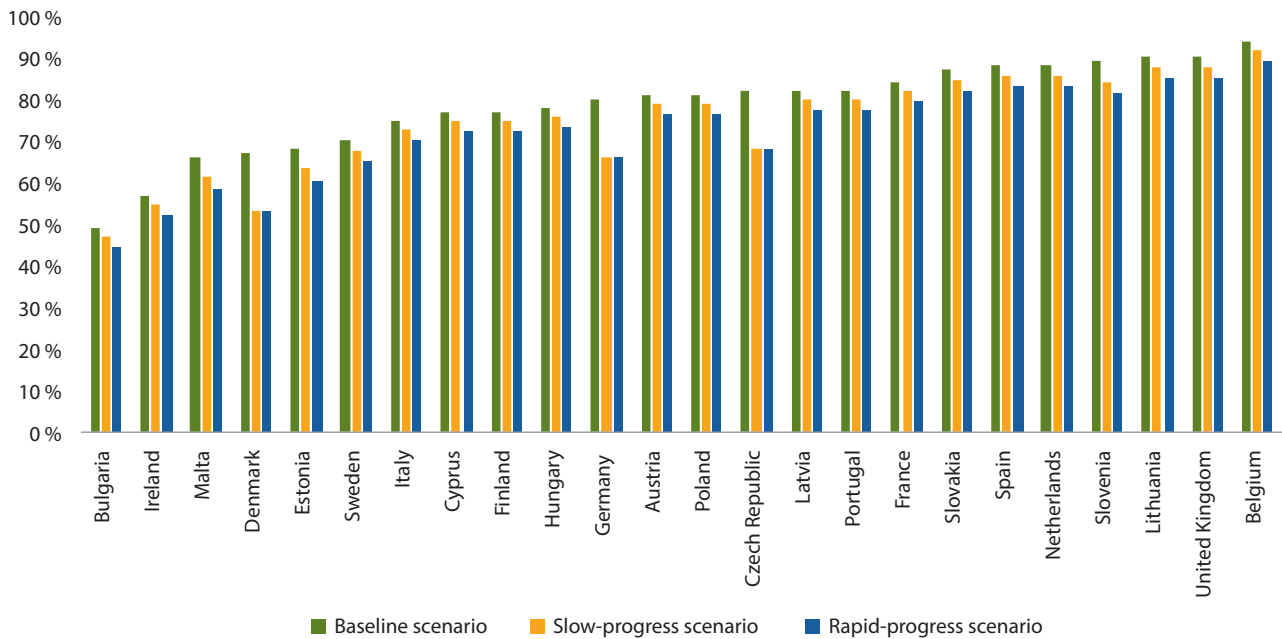
The gender gap forecasts used at the level of Member State in the progress scenarios are summarised in Figure 4.2 and Figure 4.3.

Figure 4.2. Gender gap in engineering graduates under each scenario in 2030



Source: Study calculations.

Figure 4.3. Gender gap in computing graduates under each scenario in 2030



Source: Study calculations.

4.2.2. Closing the gender gap in labour market activity (pathway 2)

Pathway 2 focuses on the potential of closing the gender gap in labour market activity by 2030 as a result of adopting such gender equality measures as improvement in childcare and other care provision, changes in various leave schemes for parents, promotion of flexible working arrangements, promotion of female entrepreneurship, promotion of gender-neutral recruitment and improved healthcare for women.

Gender gap in labour market activity of men and women is defined as follows:

$$Gap_{Part} = \left(1 - \frac{Act_rate_w}{Act_rate_m} \right)$$

where Act_rate_w stands for the activity rate of women aged 20 to 64 and Act_rate_m stands for the activity rate of men from the same age group based on Eurostat labour

force survey data. Note that if Gap_{Part} equals 1 only men are active in the labour market; if it is 0 there is equal share of men and women; and if it is negative there are more women than men in the labour force.

Estimates of the potential closure of the gender gap in labour market activity compared to the baseline were prepared for two groups of Member States:

- the 'best-performing' Member States (Sweden, Lithuania) in terms of gender gaps in labour market activity; and
- the 26 'lagging' EU Member States with higher gender gaps.

The key assumptions necessary to produce these estimates are summarised in Box 4.2 below.

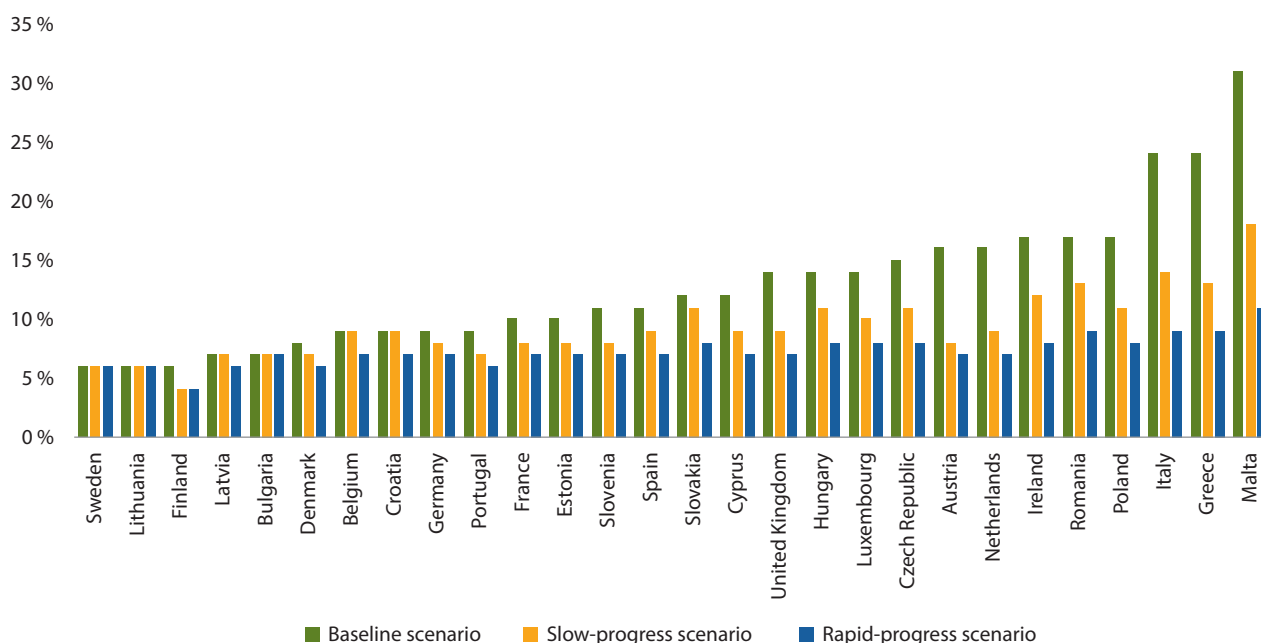


Box 4.2. Key modelling assumptions for pathway 2

1. **In the 'lagging' Member States gender equality can be further improved compared to baseline** because of sizeable gender gaps in labour market activity.
2. **In the 'best-performing' Member States extra improvements in gender equality are not assumed**, given their already high levels of equality.
3. **Countries with higher gender gaps in activity rates reduce them faster than countries with lower gender equality gaps.** This assumption is based on an analysis of historical data, which showed that there has recently been a relatively strong process of convergence in the gender gap in labour market activity across Member States. Since 2000, countries with higher gender gaps in activity rates generally reduced them much faster than countries with lower gaps.
4. **The gap in labour market activity can be closed by an increase in the number of women entering the labour market**, rather than a decrease in the number of men in the labour force. This is because EU labour market activity rates of women are perceived to be relatively low ⁽¹⁶⁾, and therefore it is likely that the number of women in the labour force can be increased.

The forecasts of gender gaps in activity rates used in the progress scenarios are summarised in Figure 4.4.

Figure 4.4. Gender gap in labour market activity under each scenario in 2030



Source: Study calculations, Eurostat and Cedefop projections.

4.2.3. Closing the gender pay gap (pathway 3)

This pathway reflects the potential for gender equality measures (such as policies and legal provisions regarding equal pay and working conditions, removing sectoral and occupational segregation, reducing the number of career breaks for women and promoting the progression of women into more senior positions) to close the gender pay gap by 2030.

The gender pay gap is defined in line with the Eurostat's definition:

$$Gap_{Pay} = \left(1 - \frac{Earn_hour_w}{Earn_hour_m} \right)$$

where $Earn_hour_w$ stands for the average gross hourly earnings of women and $Earn_hour_m$ stands for the

⁽¹⁶⁾ As outlined in the Europe 2020 strategy for smart, sustainable and inclusive growth. For more details see <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF>

average gross hourly earnings of men. Note that if Gap_{Pay} is positive men earn more than women; if it is 0 there is an equal share of men and women; and if it is negative women earn more than men. The maximum positive value of Gap_{Pay} is 1, but there is no negative limit to its value.

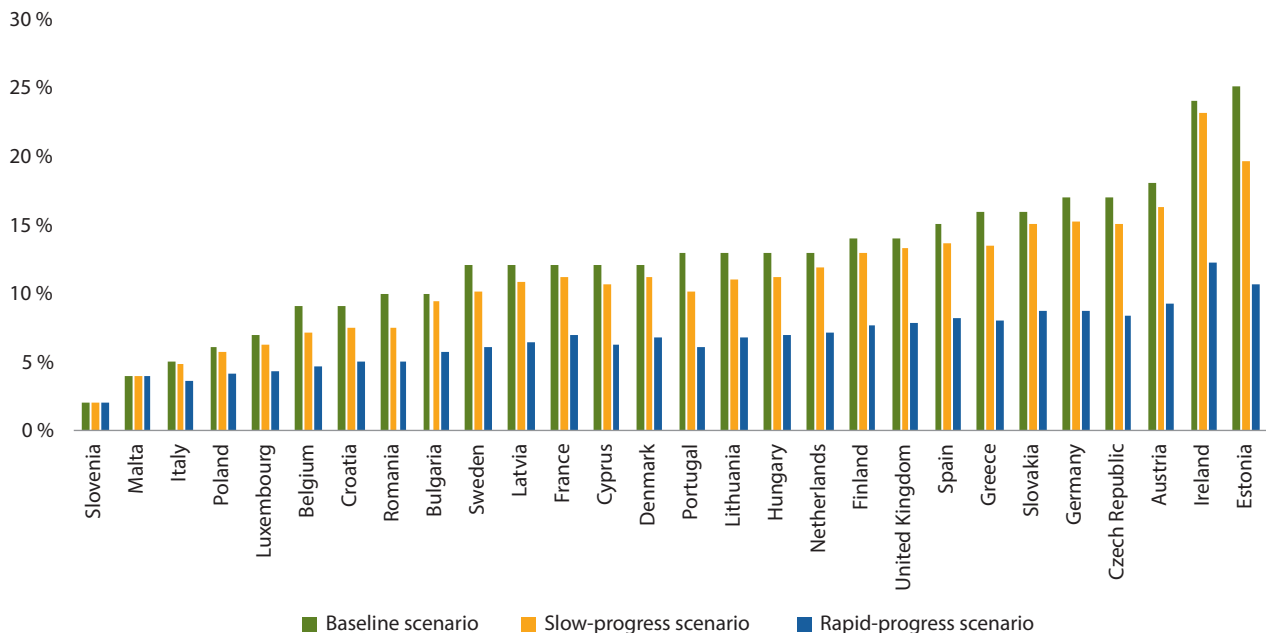
The methodology for estimating the potential closing of the gender pay gap closely follows the methodology used in pathway 2 (see Box 4.3).

Box 4.3. Key modelling assumptions for pathway 3

1. **The gender pay gap can be reduced compared to current trend estimates** (except for Slovenia, as the best-performing Member State) because most Member States still have sizeable gender pay gaps.
2. **Gender pay gaps are assumed to converge across countries**, reflecting the convergence trend identified in historical data.
3. **Countries with higher gender pay gaps reduce them faster than countries with lower gender pay gaps**, following convergence trends apparent from recent historical data.
4. **The gender pay gap can be closed by an increase in the earnings of women** rather than a decrease in earnings of men. This assumption reflects that measures aimed at reducing earnings are likely to be less acceptable than measures that aim to increase them.

Figure 4.5 summarises the estimated changes in the gender pay gap under the slow- and rapid-progress scenarios compared to the baseline.

Figure 4.5. Gender pay gap in the baseline, slow-progress and rapid-progress scenarios in 2030



Source: Study calculations, Eurostat and Cedefop projections.



4.2.4. Demographic change due to lower gender gaps (outcome 4)

Outcome 4 assesses the potential effect on fertility of increased gender equality in education and the labour market. The positive link of increased gender equality in education, labour market activity and wages to fertility is documented in many scientific studies, as described in Section 3.4 above. Increases in fertility are likely to result

from a combination of gender equality measures designed to increase gender equality in education and the labour market.

The potential increases in fertility rates were forecast for three groups of Member States, clustered according to their current level of gender equality⁽¹⁷⁾. The key assumptions necessary to produce the fertility estimates are summarised in Box 4.4 below.

Box 4.4. Key modelling assumptions for outcome 4

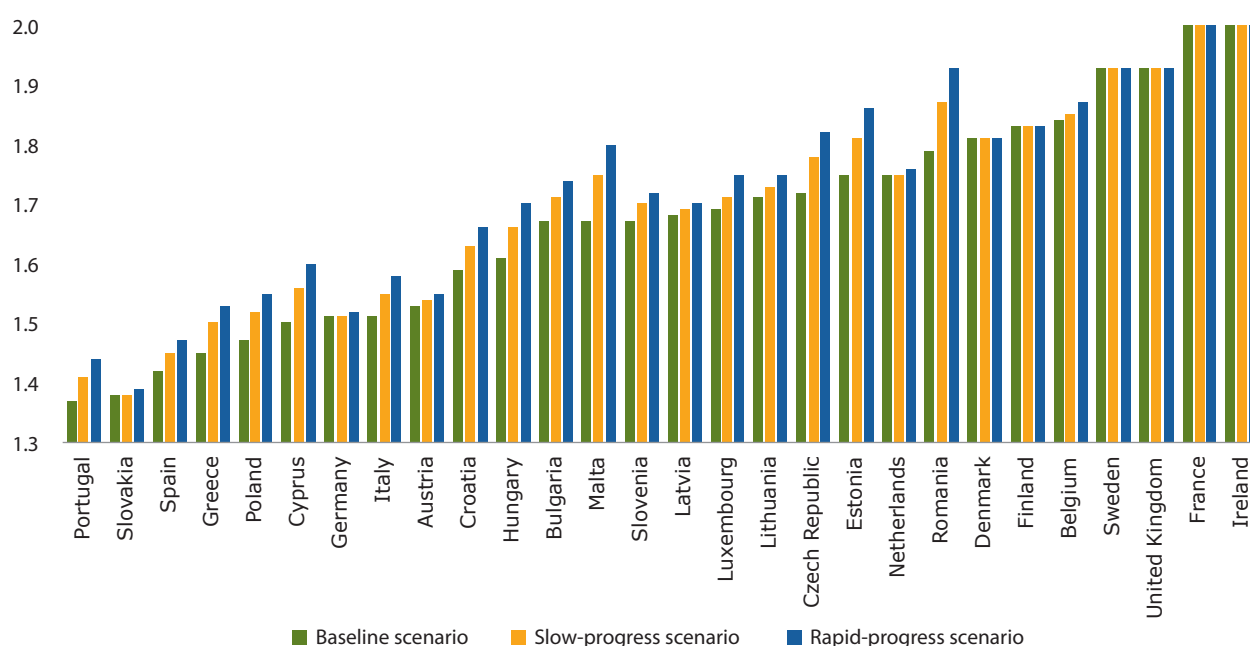
- Fertility rates can be higher than the Eurostat fertility projections if additional measures to promote gender equality are implemented.** This applies to all Member States except Ireland, France, Sweden and the United Kingdom, where Eurostat already predicts high (above 1.9) fertility rates.
- It was assumed that countries with low levels of gender equality had more potential to increase fertility rates than countries where gender equality is higher.** In high-equality countries it is probably more difficult to achieve further improvements in equality and these improvements are likely to be smaller.
- The increase in fertility does not significantly limit the ability of women to participate in the labour market** because it is likely to result from gender equality measures that promote work–life balance, such as flexible working arrangements or improvements in childcare.

The forecast fertility rates were then used to estimate the number of newborns per annum, making sure there is no double counting since average fertility rates are applied to the lifetime of a woman. We assumed that the newborn boy/girl ratio is 50:50 and then allocated newborns each year to population projections by age group (e.g.

a newborn in 2015 will be 25 years old in 2040). This new set of population projections was then used as an input into the E3ME model.

Figure 4.6 shows the fertility-rate projections in the progress scenarios compared to the baseline in 2030.

Figure 4.6. Fertility rates under each scenario in 2030



Source: Study calculations, Eurostat population projections, Cedefop labour force projections.

⁽¹⁷⁾ As measured by EIGE's Gender Equality Index.

4.2.5. Combined effects of all pathways (pathway 5)

The modelling of the combined effect of pathways 1 to 3 and outcome 4 was based on the assumption that a number of gender equality measures could be adopted simultaneously. We assumed that there was no direct substitution effect between the measures and that the effects of educational attainment, activity rates, wage rates and fertility rates were additive, i.e. that there is no double counting. For pathways 1 and 2 and outcome 4, the scenario design ensures that this is the case by clearly separating the modelling focus of each pathway.

- Pathway 1 models the effect of changes in the qualification distribution in the labour force to 2030 (labour quality). More specifically, it considers that there is an increased number of women with STEM qualifications who can enter the labour market; potential increases in labour supply due to STEM education are separate from those considered under pathway 2.
- Pathway 2 models the effect of an increase in the overall number of workers up to 2030 (labour quantity). It does not include changes in the labour force

due to changes in the number of women studying STEM. It considers increase in labour supply changes only up until 2030 and therefore is unlikely to capture the influence of changes in fertility on the labour supply.

- Outcome 4 models the impacts of gender equality measures on fertility (demographic change). This outcome is assumed to be an indirect consequence of the gender equality measures adopted under pathways 1 to 3. It is not modelled under any of these pathways to ensure that there is no double counting.

For pathway 3, data limitations meant it was not possible to fully isolate the wage differentials that were not the result of differences in education levels or activity rates and so some double counting may be possible. For example, reducing the gender pay gap may have an impact on the labour market activity of women due to higher salaries for women.

However, pathway 3 proved to have very little influence on combined outcomes during our sensitivity analysis⁽¹⁸⁾ and thus did not seriously affect the accuracy of pathway 5 as an estimate of combined impacts.

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⁽¹⁸⁾ The impact estimates were almost identical for the combination of pathways 1 and 2 and outcome 4 (i.e. omitting pathway 3) and for the combination of all pathways and outcomes.



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About the study

The study on the economic benefits of gender equality is unique in the EU context. It is the first of its kind to use a robust econometric model to estimate a broad range of macroeconomic benefits of gender equality in several broad areas such as education, labour market activity and wages.

The overall results of the study show that more gender equality would lead to:

- between 6.3 million and 10.5 million additional jobs in 2050, with about 70 % of these jobs taken by women;
- positive GDP impacts that grow over time;
- an increase in GDP per capita of up to nearly 10 % in 2050.

The study used the E3ME macroeconomic model to estimate the economic impacts of improvements in gender equality. E3ME is an empirical macroeconomic model tailored specifically to model outcomes at EU and Member State levels.

The outputs of the study on economic benefits of gender equality in the EU include nine publications:

1. Literature review: existing evidence on the social and economic benefits of gender equality and methodological approaches.
2. EU and EU Member State overviews.
3. Report on the empirical application of the model.
- 4. How the evidence was produced: briefing paper on the theoretical framework and model.**
5. How the evidence was produced: factsheet on the theoretical framework and model.
6. Economic impacts of gender equality in the EU policy context: briefing paper.
7. Economic impacts of gender equality: briefing paper.
8. How gender equality in STEM education leads to economic growth: briefing paper.
9. How closing the gender labour market activity and pay gaps leads to economic growth: briefing paper.

All publications, detailed study results and methodology can be found on EIGE's website.

The European Institute for Gender Equality (EIGE) is the EU knowledge centre on gender equality. EIGE supports policymakers and all relevant institutions in their efforts to make equality between women and men a reality for all Europeans by providing them with specific expertise and comparable and reliable data on gender equality in Europe.

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