Smoothing the adjustment to trade liberalization

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Contribution to the Project

The research paper analyzes how economic policies can be used to attenuate the adjustment costs of globalization and to compensate the losers of globalisation.

Smoothing the adjustment to trade liberalization

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Abstract

We use a dynamic general equilibrium trade model with comparative advantage, heterogeneous firms, heterogeneous workers and endogenous firm entry to analyze economic policy to compensate the losers of trade liberalization and to reduce the ensuing wage inequality. We consider several instruments of economic policy: a wage tax to redistribute income between skilled and unskilled workers; sector-specific consumption taxes and profit taxes to affect inter-sectoral wage inequality; sector-specific firm entry subsidies, worker sector-migration subsidies and training subsidies to speed up the adjustment process. We find that the re-distributional and efficiency effects of these instruments differ very much. Probably the most potent tool to reduce the wage inequality after trade liberalization are training subsidies. Although the policy also generates inefficiencies because too many workers are trained, the costs of these inefficiencies are relatively low.

Keywords: trade liberalization; wage inequality; adjustment dynamics; re-distribution;

JEL Classification: E24, F11, F16, J62

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1 Introduction

Trade with China has been recently identified as an important driver of wage inequality in developed countries (see, e.g., Ebenstein et al. [2009] or Pierce and Schott [2012]). Autor et al. [2013a] found that workers employed in sectors that are exposed to competition from Chinese imports suffer lower wages and lower employment. Thus, trade liberalization creates winners and losers which in some cases leads to strong opposition against free trade and calls for protectionist measures. Survey-based empirical evidence suggests that the political support for free trade might be higher when trade liberalization is accompanied by a compensatory mechanism (see Hays et al. [2005] for OECD countries and Ehrlich and Hearn [2013] for the U.S.). Thus, it is not surprising that countries that are more open redistribute more, as figure 1 illustrates. The question arises, what is the best way to compensate the losers of trade liberalization and to reduce the ensuing wage inequality.

To answer this question we extend the model developed in Lechthaler and Mileva [2013] to include a variety of policy instruments that could be used to redistribute the gains from trade. Our analysis shows that training subsidies are probably the most efficient instrument to reduce the wage inequality that results from trade liberalization.

The model in Lechthaler and Mileva [2013] combines a number of features that are crucial to analyze the effects of trade liberalization on wages and wage inequality. The model features two factors of production (skilled and unskilled workers) and two sectors of production with different degrees of skill intensity. This is important because the trade of a developed country with a developing country is primarily based on inter-industry trade, exploiting comparative advantages, in contrast to trade among developed countries which is primarily based on intra-industry trade. The model also features firm heterogeneity, endogenous firm entry and selection into export markets as in Melitz [2003], ingredients which have been found to be empirically important. Finally, the model is not restricted to steady state comparisons but explicitly models the transitional dynamics after trade liberalization.[1] This is crucial because it is mainly the adjustment process after trade liberalization that causes policy debates.

Our model is rich enough to capture inequality along two dimensions: the wage differential between skilled and unskilled workers, the skill premium, and the wage differential between the two sectors for a specific skill class, inter-sectoral wage inequality.

Concerning the mobility of workers we consider two different assumptions. In the first case we assume that the number of skilled workers is exogenously given. This is the standard case in many models of international trade (e.g., Bernard et al. [2007]). In the second case we endogenize the number of skilled workers by allowing unskilled workers to train to become skilled workers.

These assumptions matter very much for the long-run equilibrium. A country that is skill abundant specializes more in the production of the skill intensive good when trade is liberalized. This leads to a higher demand for skilled workers. When the number of skilled workers is exogenously given, this must manifest in a higher skill premium. It can even happen that the wage of unskilled workers goes down. In contrast, when workers can train the number of skilled workers will increase until the skill premium is driven down to its pre-liberalization level.

Although the two versions of the model imply very different long-run outcomes, the short run effects of trade liberalization are quite similar because they are driven by the slow reallocation of workers: inter-sectoral wage inequality increases,

[1] Basically, Lechthaler and Mileva [2013] puts Bernard et al. [2007] into a dynamic setting along the lines of Ghironi and Melitz [2005].

especially for skilled workers, and the skill premium also increases.

We extend the model in Lechthaler and Mileva [2013] to include several instruments of economic policy: a wage tax to redistribute income between skilled and unskilled workers; sector-specific consumption taxes and profit taxes to affect inter-sectoral wage inequality; sector-specific firm entry subsidies, worker sector-migration subsidies and training subsidies to speed up the adjustment process.

We find that the re-distributional and efficiency effects of these instruments differ very much. An increase in the wage tax on skilled workers that finances a wage subsidy for unskilled workers can dampen the increase in the skill premium and thus the increase in wage inequality, but it reduces the incentives to invest in training and hurts the skilled workers in the import-competing sector to such an extent that they suffer temporary wage reductions.

Temporary, sector-specific taxes on consumption and profits can not only reduce inter-sectoral wage inequality but also the skill premium. Instead of the fast increase in wage inequality that follows trade liberalization without any accompanying policy intervention, the increase in wage inequality becomes much more gradual and thus probably easier to digest. However, the policy distorts the reallocation decision of firms and workers and thereby reduces aggregate consumption.

Firm entry subsidies are a rather blunt tool. They fail to speed up the adjustment process sustainably and lead to large jumps in aggregate consumption. Worker's sector migration subsidies have more persistent effects. They do not only affect the sector migration of workers but also the reallocation of firms. However, both instruments have adverse effects on wage inequality.

Probably the most potent tool are training subsidies. Naturally, they lead to a higher number of skilled workers. This makes unskilled workers scarcer and increases their wage. Skilled workers become more abundant and the skilled wage is lowered. Thus, the skill premium is reduced and with it overall wage inequality. Although the policy also generates inefficiencies because too many workers are trained, the costs of these inefficiencies are relatively low.

2 Literature review

Economists have invested a great deal of effort in analyzing the effect of international trade on the relative distribution of income. Most studies on the distributional effects of international trade are based on either the Heckscher-Ohlin or the Ricardo-Viner model. The Heckscher-Ohlin model predicts that the owners of abundant production factors gain from trade while the owners of scarce factors lose, whereas the Ricardo-Viner model predicts that opening up to trade harms factors specific to the import-competing sector. More recent contributions have also analyzed the effects of international trade on the distribution of income in trade models with heterogeneous firms. In general, there is broad agreement among economists that the globalization process will generate net aggregate benefits but will also harm some groups in society. Governments in most developed countries have implemented some sort of compensation scheme for the losers from trade liberalization. The most well-known compensation policy is the Trade Adjustment Assistance (TAA) program of the United States. The TAA program is a set of policies that offer loan assistance, plus measures to compensate displaced workers with extended unemployment benefits, relocation expenses and training for jobs in a new industry. Canada and Australia have implemented similar schemes, such as the General Adjustment Assistance Program and Special Adjustment Assistance.

Yet, surprisingly little research has been devoted to the question of how welfare policies can optimally compensate the losers of globalization. AsFeenstra [1998, p.48] has put it: "We know surprisingly little about redistribution schemes, other than that they often fail".

Following the lead by Dixit and Norman [1980, 1986], most of the earlier papers on redistribution schemes concentrate on the possibility of compensating the losers from trade without exhausting the net gains from trade. The policy analyzed by Dixit and Norman specifies a scheme of commodity taxes and subsidies such that consumers face autarky prices for goods and factors. Free trade then leaves individuals as well off as under autarky. Dixit and Norman [1980, 1986] show that such a policy raises non-negative revenue for the government and thus results in a Pareto improvement. There are several limitations of the earlier literature in the tradition of Dixit and Norman [1980, 1986]. It assumes factor markets to be perfectly competitive and therefore abstracts from unemployment. Consequently, the literature cannot answer the important question of how to compensate unemployed workers for their job loss (Kletzer [2004]).

The compensation scheme considered by Dixit and Norman [1986] has little repercussions in the real world. As Davidson and Matusz [2006, p. 724] have put it: "We know of no government that has ever considered such a scheme to compensate workers harmed by changes in trade policies". In contrast, labor market policies, such as wage or training subsidies or minimum wages, are at the heart of the policy debate on how to assist the losers of the globalization process. Much of the earlier literature uses static models of international trade and, thus, considers only the long-run effect of trade liberalization. Hence, the literature abstracts from the potentially large short- and-medium-run costs of adjusting to trade liberalization. In addition, labor is usually supplied inelastically and the skill level of workers is exogenous. Therefore, welfare policies have, by assumption, no effect on the incentives to work or the education decision of workers. Yet, these effects are at the heart of the policy debate on the adverse effects of globalization.

We contribute to the literature by addressing some of these limitations. We abstract from unemployment issues because our focus is different in the sense that we analyze re-distribution in the context of increased trade between developed and developing countries. Thus, we focus on the effect of increased inter-industry trade on between-group inequality rather than the effect of intra-industry trade on unemployment and within-group inequality. Recent empirical papers show that adjustment costs faced by workers who want to move between sectors are high (see Artuç et al. [2010], Dix-Carneiro [2010]) which means that trade could give rise to significant inter-industry wage inequality. However, we address the rest of the outlined limitations. We analyze a large variety of labor market policies and their effects on inequality and employment across sectors. We have a general equilibrium dynamic model which allows us to study the short-run as well as the long-run effects of trade liberalization. Finally, in our model the skill level and the supply of skilled labor are endogenous so that we can analyze the effects of redistributive policies such as training subsidies on the decision of workers. Several other recent papers also address some of these limitations in the literature on trade and re-distribution but they either have a different focus of analysis than us or limit their analysis to particular policy scenarios.

Janeba [2003] analyzes the role of government policies in the case where the wage gap between high-skilled and low-skilled workers is widening due to increasing foreign competition in low-skilled intensive goods. A two-period, three-sector general-equilibrium model of a small open economy is developed in which individuals choose whether to invest in skills or not. The paper shows that increasing import competition or lowering wage taxes on skilled workers widens inequality when the skill distribution is exogenous because increased demand for skilled labor manifests in increased skilled wages.

But when the skilled distribution is endogenous, the opposite occurs because lowering taxes on skilled workers or import competition acts as an additional incentive to become skilled, i.e. increased demand for skilled labor manifests in increased quantity of skilled labor. Similarly to us, Janeba [2003] analyzes the role of wage taxes when the education decision of workers is exogenous or endogenous but he uses a two-period model which makes it difficult to discuss short- versus long-run trade-offs of government policies. In addition, the trade experiment performed by Janeba [2003]is unilateral liberalization and implicitly assumes that the terms of trade are exogenous. Lechthaler and Mileva [2013] show that the effects of unilateral and bilateral trade liberalization can differ very much and argue that bilateral trade liberalization is the more relevant case.

Davidson and Matusz [2006] compare a variety of labor market policies designed to compensate workers that are harmed by trade liberalization. Their model incorporates two sectors, a low- and a high-tech sector, and two types of workers, a low- and a high-ability worker. Labor supply in the model is fixed but workers choose a sector, and acquire the necessary training, based on expected income. In the initial equilibrium, the low-tech sector is protected by a tariff. The removal of the tariff increases the real wage in the high-tech sector but reduces the real wage in the low-tech sector. The losers from liberalization consist of "Stayers" that are stuck in the low-tech sector and "movers" that go through costly training to switch from the low- to the high-tech sector. The authors then use the model to analyze whether unemployment benefits, wage subsidies, employment subsidies or training subsidies compensate the losers of globalization at the lowest cost. They find compensation policies should not be general but always targeted to those workers harmed by liberalization. In a follow-up paper, Davidson et al. [2007] show that compensation policies can increase the likelihood that trade liberalization is chosen in a political process. This is an important result, as it suggests that compensation policies might be necessary to reap the aggregate benefits of free trade. However, the trade experiment analyzed by Davidson and Matusz [2006] is unilateral liberalization and implicitly assumes that the terms of trade are exogenous.

Itskhoki [2008] considers optimal redistribution through the tax system in a model with heterogeneous worker-entrepreneurs who earn firm revenues as income. Entrepreneurs differ in terms of their productivity and face fixed costs of exporting. As a consequence, trade integration disproportionately benefits the most productive entrepreneurs, which are able to engage in export activities, and thus increases income inequality. The government chooses income taxes so as to maximize a social welfare function that features positive inequality aversion. Itskhoki [2008] shows that trade liberalization increases the incentives for redistribution, but also aggravates the equity-efficiency trade-off associated with re-distribution. The paper does not consider labor market institutions and restricts its analysis to tax policies. In addition, it focuses on intra-industry trade between countries while inter-industry trade is more important if one aims to analyze redistribution in the context of increased trade between developed and developing countries.

Egger and Kreickemeier [2009] build a model with heterogeneous firms who pay firm-specific wages to ex-ante identical workers. Workers have fairness preferences and expect that the most productive firms will pay higher wages so that free trade gives rise to within-group inequality. The authors then analyze the effects of a redistribution scheme consisting of lump-sum transfers to all workers financed by a linear profit tax. They show that such a redistribution scheme can, under certain conditions, lead to a more equal income distribution than in autarky without exhausting the gains from trade. This paper restricts its analysis to static outcomes and, therefore, considers only the long-run effect of trade liberalization. Its analysis of redistribution abstracts from the potentially large short- and medium-run costs of adjusting

to trade liberalization. Like Itskhoki [2008] the paper focuses on intra-industry trade.

de Pinto [2013] investigates the impact of three different forms of unemployment benefits : (i) a wage tax paid by employees, (ii) a payroll tax paid by firms and (iii) a profit tax paid exclusively by exporters. He uses a model with heterogeneous firms and workers who operate in unionized labor markets. Trade liberalization results in winners (the high-skilled workers) and losers (the low-skilled workers). His analysis reveals that there is a threshold level of unemployment benefits where all trade gains are destroyed, but this threshold varies with the unemployment benefit's source of funding. There is a clear-cut ranking in terms of welfare for the chosen funding of the unemployment benefit: 1. wage tax, 2. profit tax, 3. payroll tax. This paper also restricts its analysis to static outcomes and focuses on intra-industry trade.

Coşar [2013] builds an overlapping generations model where workers accumulate sector-specific human capital on the job that is not transferable across sectors. Workers can either be employed in the exporting sector in which the economy has a comparative advantage or in the import-competing sector of the economy which is initially protected by a tariff. Coşar [2013] uses the model to simulate the dynamic effects of trade liberalization that Brazil underwent between 1988 and 1991. Once workers in the import-competing sector lose their jobs as a result of trade liberalization, they might experience long unemployment spells or find lower-paid jobs in the export sector due to loss of sector-specific human capital. The author distinguishes between three policy scenarios. In the first scenario, workers receive no income support after trade liberalization. In the second scenario, workers who become unemployed receive unemployment benefits for a limited period of time.[2] In the third scenario, old workers who were employed in the previously protected import-competing sector and move to the export-oriented sector after trade liberalization receive a subsidy. Coşar [2013] finds that relative to the scenario without income support, unemployment insurance slows down the reallocation of workers from the import-competing to the exporting sector and therefore leads to an output loss. In contrast, targeted employment subsidies can not only compensate the losers of liberalization but can also increase aggregate output. Therefore, Coşar [2013] concludes that compensation policies should foster the mobility of workers adversely affected by liberalization. Similarly to Davidson and Matusz [2006], however, this paper assumes exogenous terms of trade and restricts its analysis to a unilateral liberalization scenario.

Finally, without a formal model, Kletzer [2004] sheds light on the effectiveness of a wage insurance program in compensating the losers of trade liberalization, and compares the program to unemployment insurance benefits. Wage insurance is paid to workers who were employed in the import-competing sector, conditional on finding a new job. In contrast to unemployment benefits, wage insurance increases the returns to job search, since it is paid only to workers who find a new job. The incentives to search are greater for workers who can expect high re-employment losses.

3 Theoretical model

Our model economy consists of two countries, Home (H) and Foreign (F). Each country produces two goods, good 1 and good 2. The production of each good requires two inputs, skilled and unskilled labor. The sector that produces good 1 is skill-intensive, i.e., the production of good 1 requires relatively more skilled labor than the production of good 2. We consider two versions of the model: in the first a country's endowments with skilled and unskilled labor are fixed while

[2] In fact, Brazil introduced an extensive unemployment insurance system just before the trade liberalization.

in the second only the total labor endowment is fixed and skilled and unskilled labor is determined endogenously. In the first version, H has a comparative advantage in producing good 1 because it has a higher relative endowment with skilled labor. Similarly, F has a comparative advantage in sector 2 because it has a higher relative endowment with unskilled labor. In the second version, the supplies of skilled and unskilled labor become endogenous by allowing unskilled workers to train and become skilled. In this scenario, H has a comparative advantage in the production of the skill-intensive good due to a cheaper training technology. We assume that at the pre-liberalization steady state unskilled labor is more abundant than skilled labor in both countries in order to generate a positive skill-premium.[3] In the long run, all factors of production are assumed to be perfectly mobile between sectors but not across countries. In the short run, however, workers are imperfectly mobile both across sectors and across skill-classes.

We assume endogenous firm entry and heterogeneous firms as in Melitz [2003] and Bernard et al. [2007]. Firms have to pay a sunk entry cost to become active in a specific sector to which they are bound for their whole life-time. After paying the sunk entry cost the firms draw their productivity from a random distribution. Firms have to pay fixed costs of exporting which implies that only the most productive firms export. In contrast to Melitz [2003], but in line with Ghironi and Melitz [2005], there are no fixed costs of production, so that every entering firm takes up production.

In each country we add a variety of policy instruments: a wage tax, a consumption tax, a profit tax, a subsidy on sector migration, a subsidy on training and a subsidy on firm entry. In each case the instruments can differ between the two sectors, the wage tax and the migration subsidy can also differ between skill classes. We assume that the government budget constraint is balanced at all times. Depending on the configuration of instruments we consider, the policy instrument could be an exogenous policy variable or an endogenous variable that balances out the government budget constraint. In the following section we describe all the decision problems in H; equivalent equations hold for F.

3.1 Households

Each country consists of one large representative household which maximizes the present discounted value of utility derived from consumption:

$$E_t \left\{ \sum_{i=0}^{\infty} \gamma^i \left[log\left(C_{t+i}\right) - Cost_{t+i} \right] \right\}, \tag{1}$$

where γ is the subjective discount factor and the term $Cost_{t+i}$ summarizes the (potential) disutility from migration and training (see, e.g., Dix-Carneiro [2010]). We assume that all workers in H are members of this large household which pools their labor income. This implies that the distribution of labor income can be ignored for the consumption decision. This is a standard assumption in the macroeconomic literature (see, e.g., Andolfatto [1996]). Then, the household faces the following inter-temporal budget constraint:

$$\begin{aligned} &B_{t+1} + \widetilde{v}_{1t} N_{h,1t} x_{1t+1} + \widetilde{v}_{2t} N_{h,2t} x_{2t+1} + C_t = (1+r_t) B_t + (\tilde{d}_{1t} + \tilde{v}_{1t}) N_{d,1t} x_{1t} + (\tilde{d}_{2t} + \tilde{v}_{2t}) N_{d,2t} x_{2t} \\ &+ \left(1 - \chi^s_{1t}\right) w^s_{1t} S_{1t} + \left(1 - \chi^s_{2t}\right) w^s_{2t} S_{2t} + \left(1 - \chi^l_{1t}\right) w^l_{1t} L_{1t} + \left(1 - \chi^l_{2t}\right) w^l_{2t} L_{2t}. \end{aligned} \tag{2}$$

The household spends its income on purchases of real risk-free bonds B_{t+1} and shares x_{it+1} of ownership in all domestic firms that operate at time t, $N_{h,it}$, at price $\widetilde{v}_{it}$. When deciding how many shares to purchase, the household considers

[3] What matters for comparative advantage are relative endowments, so skilled labor can be scarce in both countries.

all operating firms including incumbents $N_{d,it}$ and new entrants $N_{e,it}$, which implies that $N_{h,it} = N_{d,it} + N_{e,it}$. However, each period a fraction δ of all firms dies. Thus, only $N_{d,it+1} = (1-\delta)N_{h,it}$ will actually produce and generate profits to pay dividends $\tilde{d}_{it}$. The remainder of the household income is spent on the aggregate consumption good C_t. The household obtains income from interest on its bond holdings $(1+r_t)B_t$, dividend income $\tilde{d}_{it}$ from owning shares in $N_{d,it}$ firms, capital income from selling the shares in $N_{d,it}$ firms, and wage income w^s_{it} and w^l_{it} from supplying skilled S_{it} and unskilled labor L_{it}. The wage income of skilled and unskilled workers is subject to potentially sector-specific proportional wage taxes, χ^s_{it} and χ^l_{it}.[4] The budget constraint is written in aggregate consumption units.

The household chooses C_t, B_{t+1}, and x_{it+1} for sector i. The corresponding Euler equations for bond and share holdings are:

$$(C_t)^{-1}(1+\eta B_{t+1}) = \gamma E_t\left[(C_{t+1})^{-1}(1+r_t)\right] \tag{3}$$

$$\widetilde{v}_{it} = \gamma(1-\delta)E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-1}\left(\widetilde{v}_{it+1}+\tilde{d}_{it+1}\right)\right] \tag{4}$$

The aggregate consumption good C_t is a Cobb-Douglas composite of the goods produced in the two sectors $C_t = C_{1t}^{\alpha}C_{2t}^{1-\alpha}$, where α is the share of good 1 in the consumption basket for both H and F. Then, the relative demand for good 1 is $C_{1t} = \alpha\frac{P_t}{P_{1t}}C_t$ and for good 2 is $C_{2t} = (1-\alpha)\frac{P_t}{P_{2t}}C_t$, where $P_t = \left(\frac{P_{1t}}{\alpha}\right)^{\alpha}\left(\frac{P_{2t}}{1-\alpha}\right)^{1-\alpha}$ is the price index that buys one unit of the aggregate consumption basket C_t.[5]

Goods 1 and 2 are consumption baskets defined over a continuum of varieties Ω_i such that $C_{it} = \left[\int_{\omega\epsilon\Omega_i} c_{it}(\omega)^{\frac{\theta-1}{\theta}}d\omega\right]^{\frac{\theta}{\theta-1}}$, where $\theta > 1$ is the elasticity of substitution between varieties. Varieties are internationally traded. The consumption based price index for each sector is $P_{it} = \left[\int_{\omega\epsilon\Omega_i} p_{it}(\omega)^{1-\theta}d\omega\right]^{\frac{1}{1-\theta}}$ and the household demand for each variety is $c_{it} = \left(\frac{p_{it}}{P_{it}}\right)^{-\theta}C_{it}$. Let us define $\rho_{it} \equiv \frac{p_{it}}{P_t}$ and $\psi_{it} \equiv \frac{P_{it}}{P_t}$ as the relative prices for individual varieties and for the sector baskets, respectively. Then, we can rewrite the demand functions for varieties and sector baskets as $c_{it} = \rho_{it}^{-\theta}C_{it}$ and $C_{it} = \alpha\psi_{it}^{-1}C_t$, respectively.

3.2 Labor supply

We consider two versions of the model. In the first version, we make the assumption that the overall endowments with skilled and unskilled workers are exogenously fixed. This resembles the case in Bernard et al. [2007]. In the second version, we relax this assumption by allowing unskilled workers to train and become skilled workers (see, e.g., Larch and Lechthaler [2011]).

In both versions of the model, workers are perfectly mobile between sectors in the long run. However, in the short run, adjustment of workers will be slowed by adjustment costs: each worker has to pay a random, idiosyncratic sector migration cost in order to be able to switch sectors. We also assume that workers retire at rate s and are replaced by newly entering workers. These newly entering workers are free in their choice of sector and, thereby, also contribute to the reallocation of workers. Thus, even if the sector migration cost was so large that none of the incumbents would decide to switch sectors, the constant flow of more mobile new entrants would assure full adjustment of labor in the long run. We first describe the version of the model without training.

[4] For the most part we use the same wage tax for both sectors, since we think that this is the more realistic case, but in two experiments we analyze sector-specific wage taxes.

[5] Prices are gross prices, i.e., including the consumption tax.

3.2.1 Worker mobility without training

Skilled workers are free to move between sectors but doing so implies a positive idiosyncratic sector migration cost, measured in disutility,[6] which is represented by an idiosyncratic $\varepsilon_t^s \geq 1$, drawn each period from a random distribution $F(\varepsilon^s)$. Unskilled workers can also move between sectors but they draw their sector migration cost ε_t^l from a different distribution $H(\varepsilon^l)$. Since skilled and unskilled workers face symmetric mobility decisions, it suffices to describe the decision of skilled workers. Analogous equations hold for unskilled workers.

We assume that the government can subsidize the migration of workers, so that, a worker will move from sector j to sector i if:[7]

$$\frac{V_{it}^s}{\left(1-\chi_{jit}^{mS}\right)\varepsilon_t^s} > V_{jt}^s, \tag{5}$$

where χ_{jit}^{mS} is the migration subsidy that skilled workers receive if they migrate from sector j to i. Vice versa, a worker in sector i will move to sector j if $\frac{V_{jt}^s}{\left(1-\chi_{ijt}^{mS}\right)\varepsilon_t^s} > V_{it}^s$. Equation 5 defines a threshold, $\bar{\varepsilon}_t^s$, for which a worker is indifferent between switching and not switching the sector

$$\overline{\varepsilon_t^s} = \frac{V_{it}^s}{V_{jt}^s}\frac{1}{\left(1-\chi_{jit}^{mS}\right)} \tag{6}$$

and the probability of switching from sector j to sector i is $\eta_{jit}^s = F(\max\left(\overline{\varepsilon_t}^s, \varepsilon_{\min}^s\right))$ and from sector i to sector j is $\eta_{ijt}^s = F\left(\max\left(\frac{1}{\overline{\varepsilon_t}^s}, \varepsilon_{\min}^s\right)\right)$. $\varepsilon_{\min}^s$ is the minimum moving cost that the worker has to pay in order to switch sectors. We assume that $\varepsilon_{\min}^s \geq 1$ so that only one of the two rates can be positive, the other has to be zero.

A skilled worker's value of being employed in sector i is defined as:

$$V_{it}^s = \left(1-\chi_{it}^s\right) w_{it}^s + \gamma(1-s)\left(\frac{C_{t+1}}{C_t}\right)^{-1}\left[(1-\eta_{ijt+1}^s)V_{it+1}^s + \int_{\varepsilon_{\min}^s}^{1/\bar{\varepsilon}_{t+1}^s} \frac{V_{jt+1}^s}{\left(1-\chi_{ijt+1}^{mS}\right)\varepsilon_{t+1}^s} dF\left(\varepsilon_{t+1}^s\right)\right], \tag{7}$$

where s is the probability of retiring. The worker's value is a function of the after-tax real wage that the worker earns and the expected discounted future value,[8] adjusted for the probability of survival, and averaged over the cases where the worker will choose to stay in the same sector or switch to the other sector, taking account of eventual sector migration costs and subsidies.

In order to keep the working population constant, we assume that each period the retiring workers are replaced by newly entering workers, Se_{it}. The newly entering workers have to choose the sector in which they want to be employed. We assume that this decision is based on the relative payoffs in sectors 1 and 2. If the value in sector 1 is higher than the value in sector 2, then relatively more workers will enter sector 1, but we avoid the extreme assumption that all entering workers flock to one sector. To assure stationarity in the steady state, we have to 'weigh' the payoffs of each sector with

[6] As in Dix-Carneiro [2010] we assume that the sector migration cost is paid in terms of utility, which has the benefit that the sector migration cost need not be traded in the market.

[7] We interpret the sector migration cost in a similar way as Iceberg trade costs. When workers move, a certain share of their value V_{jt}^s in the other sector 'melts away', so that only $1/\varepsilon_t^s$ is left. The advantage of modeling migration costs in this way is that migration costs depend positively on the wage income of the worker, i.e., workers with a higher income suffer higher migration costs.

[8] The appropriate discount factor is $\gamma\left(\frac{C_{t+1}}{C_t}\right)^{-1}$, taking account of changes in marginal utility.

the number of workers in that sector, so that the ratio of workers entering each sector is given by $\frac{Se_{1t}/S_{1t}}{Se_{2t}/S_{2t}} = \frac{V^s_{1t}}{V^s_{2t}}$.[9]

Having characterized the exit and entry behavior of workers, we can now write the laws of motion for workers. The number of skilled workers in sector i at the end of period t equals the number of incumbents who did not switch sectors, the number of workers who switched from sector j to sector i and the new entrants, taking account of the retirement rate, such that $S_{it} = (1-s)\left[(1-\eta^s_{ijt})S_{it-1} + \eta^s_{jit}S_{jt-1} + Se_{it-1}\right]$. In this version of the model, the country supply of skilled workers is fixed so that $S = S_{1t} + S_{2t}$. Finally, in equilibrium the total number of workers that retire has to equal the number of new entrants that survive $sS = (1-s)(Se_{1t} + Se_{2t})$.

Remember that in the long run workers are fully mobile between sectors. Then, for each skill class the values in both sectors need to be the same, which implies that there is full wage equalization across sectors in the steady state. Thus, in the long run skill premia are equal across sectors ($\frac{w^s_1}{w^l_1} = \frac{w^s_2}{w^l_2}$).

3.2.2 Worker mobility with training

In this section, we relax the assumption of perfect immobility between skill classes, by allowing unskilled workers of each sector to train to become skilled workers in their sector. We model the training decision analogously to the sector migration decision of the previous section. Unskilled workers who want to become skilled have to pay a positive training cost, measured in disutility, which is represented by an idiosyncratic ε^i_t drawn each period from a random distribution $\Gamma(\varepsilon^i)$. We assume that the government can subsidize the training costs of unskilled workers with a sector-specific training subsidy χ^t_{it}. Unskilled workers in sector i train if the value of being skilled is high enough to justify the training cost, after the subsidy i.e.,

$$\frac{V^s_{it}}{(1-\chi^t_{it})\,\varepsilon^i_t} > V^l_{it}. \tag{8}$$

Equation 8 defines a threshold $\bar{\varepsilon}^i_t$ for which a worker is indifferent between training and not training

$$\bar{\varepsilon}^i_t = \frac{V^s_{it}}{V^l_{it}}\frac{1}{1-\chi^t_{it}}, \tag{9}$$

so that the probability of training is $\eta_{it} = \Gamma\left[\max(\bar{\varepsilon}^i_t, \pi\varepsilon^i_{\min})\right]$ where $\varepsilon^i_{\min}$ is the minimum training cost that unskilled workers have to pay in order to become skilled and $\pi \geq 1$ is a parameter.

While the value function for skilled workers remains the same as in the model with fixed labor endowments, the value function for unskilled workers must be re-defined to take account of the possibility of training such that,

$$\begin{aligned} V^l_{it} &= \left(1-\chi^l_{it}\right) w^l_{it} + \\ &\gamma(1-s)\left(\frac{C_{t+1}}{C_t}\right)^{-1}\left[(1-\eta^l_{ijt+1}-\eta_{it+1})V^l_{it+1} + \int_{\varepsilon^l_{\min}}^{1/\bar{\varepsilon}^l_{t+1}} \frac{V^l_{jt+1}}{\left(1-\chi^{mL}_{ijt+1}\right)\varepsilon^l_{t+1}} dH(\varepsilon^l_{t+1}) + \int_{\pi\varepsilon^i_{\min}}^{\bar{\varepsilon}^i_{t+1}} \frac{V^s_{it+1}}{\left(1-\chi^t_{it+1}\right)\varepsilon^i_{t+1}} d\Gamma(\varepsilon^i_{t+1})\right]. \end{aligned} \tag{10}$$

Since training is now endogenous, newly entering workers not only have to decide about their sector but also about their training. We model this decision analogously to the decision about switching sectors, assuming that the cost of

[9] If we did not weigh the payoffs, then equalization of payoffs and wages across sectors would only be possible if workers were split equally across sectors.

training for newly entering workers is $\varepsilon^i_{\min}$. This implies $\frac{Se_{it}/S_{it}}{Le_{it}/L_{it}} = \frac{V^s_{it}}{V^l_{it}} \frac{1}{\varepsilon^i_{\min}}$.[10]

The number of skilled workers in sector i at the end of period t equals the number of incumbents who did not switch sectors, the number of workers who moved from sector j to sector i, the newly trained unskilled workers and the new entrants, taking account of the retirement rate, such that $S_{it} = (1-s)\left[(1-\eta^s_{ijt})S_{it-1} + \eta^s_{jit}S_{jt-1} + Se_{it-1} + \eta_{it}L_{it-1}\right]$. The number of unskilled workers in sector i at the end of period t equals the number of incumbents who neither switched sectors nor trained, the number of unskilled workers who moved from sector j to sector i and the new entrants, taking account of the retirement rate, such that $L_{it} = (1-s)\left[(1-\eta^l_{ijt} - \eta_{it})L_{it-1} + \eta_{jit}L_{jt-1} + Le_{it-1}\right]$. Finally, in equilibrium the total number of workers that retire has to equal the number of new entrants that survive such that $sENDOW = (1-s)(Se_{1t} + Le_{1t} + Se_{2t} + Le_{2t})$, where $ENDOW = S_t + L_t$ is the total endowment with labor for country H.

3.2.3 Measures for wage inequality

In order to analyze the effect of trade liberalization on wage inequality, we define a number of wage inequality measures based on after-tax wages. First, we define two measures of wage inequality across sectors. They measure the relative percentage difference across sectoral wages for skilled and unskilled workers

$$\begin{aligned} IndexS_t &= \left(\frac{(1-\chi^s_{1t})w^s_{1t}}{(1-\chi^s_{2t})w^s_{2t}} - 1\right)100, \\ IndexL_t &= \left(\frac{(1-\chi^l_{1t})w^l_{1t}}{(1-\chi^l_{2t})w^l_{2t}} - 1\right)100. \end{aligned}$$

Note that these indices are zero at the steady state, due to the assumption of full long run mobility across sectors. However, they might be different from zero out of the steady state. It is one of the advantages of our dynamic model that it can capture these temporary increases in inequality.

To measure wage inequality across skill classes we define a skill premium for each sector and an average skill premium. The skill premium for sector i is defined as the percentage difference between the wage of skilled and unskilled workers

$$Skill_{it} = \left(\frac{(1-\chi^s_{it})w^s_{it}}{(1-\chi^l_{it})w^l_{it}} - 1\right)100.$$

To define the average skill premium for each country, we use the average after-tax wage of skilled workers, $w^s_t = \frac{S_{1t}}{S_t}(1-\chi^s_{1t})w^s_{1t} + \frac{S_{2t}}{S_t}(1-\chi^s_{2t})w^s_{2t}$, and the average wage of unskilled workers, $w^l_t = \frac{L_{1t}}{L_t}(1-\chi^l_{1t})w^l_{1t} + (1-\chi^l_{2t})\frac{L_{2t}}{L_t}w^l_{2t}$ to obtain

$$Skill_t = \left(\frac{w^s_t}{w^l_t} - 1\right)100.$$

Finally, we measure aggregate wage inequality for each country by constructing a theoretical Gini index, which is a standard measure of inequality. The Gini index measures the extent to which the distribution of after-tax wages among the different groups of workers within each country deviates from a perfectly equal distribution. A Gini index of 0 means perfect equality, while an index of 1 means perfect inequality. The Gini coefficient is defined as half the relative mean difference of a wage distribution. Defining the average after-tax wage for country H as $w_t = \frac{S_{1t}}{S_t+L_t}(1-\chi^s_{1t})w^s_{1t} + \frac{S_{2t}}{S_t+L_t}(1-\chi^s_{2t})w^s_{2t} + \frac{L_{1t}}{S_t+L_t}(1-\chi^l_{1t})w^l_{1t} + \frac{L_{2t}}{S_t+L_t}(1-\chi^l_{2t})w^l_{2t}$, the Gini coefficient for country H is

[10] Again, this is the simplest assumption that assures a stationary steady state.

$$Gini_t = \frac{1}{2w_t}\left(\frac{S_{1t}}{S_t+L_t}\left|w^s_{1t}(1-\chi^s_{1t})-w_t\right| + \frac{S_{2t}}{S_t+L_t}\left|w^s_{2t}(1-\chi^s_{2t})-w_t\right| + \frac{L_{1t}}{S_t+L_t}\left|w^l_{1t}(1-\chi^l_{1t})-w_t\right| + \frac{L_{2t}}{S_t+L_t}\left|w^l_{2t}(1-\chi^l_{2t})-w_t\right|\right). \quad (11)$$

The term in parentheses is a measure of dispersion in which we calculate the absolute deviations from the average income and weigh those by the population shares.

3.3 Production

There are two sectors of production in each country. A continuum of firms with heterogeneous productivity operates in each sector. To avoid cumbersome notation, we omit a firm-specific index in the following description of production. The production technology is assumed to be Cobb-Douglas in the two inputs of production $Y_{it} = z_i S_{it}^{\beta_i} L_{it}^{(1-\beta_i)}$, where z_i is firm-specific productivity, while S_{it} and L_{it} is the amount of skilled and unskilled labor used by a firm. β_i is the share of skilled labor required to produce one unit of output Y_i in sector i. Sector 1 is assumed to be skill-intensive and sector 2 unskilled-intensive which implies that $1 > \beta_1 > \beta_2 > 0$. The labor market is assumed to be perfectly competitive implying that the real wage of both skilled and unskilled workers equals the values of their marginal products of labor. In addition, workers are perfectly mobile across firms which implies that all firms pay the same wage. Consequently, relative labor demand can be described by the following condition:

$$\frac{w^s_{it}}{w^l_{it}} = \frac{\beta_i}{(1-\beta_i)}\frac{L_{it}}{S_{it}}, \quad (12)$$

which says that the ratio of the skilled real wage w^s_{it} to the unskilled real wage w^l_{it} for sector i is equal to the ratio of the marginal contribution of each factor into producing one additional unit of output. Note that this condition uses before-tax producer wages and implies that relative demand for labor is the same across firms within a sector. Since relative demand for labor is independent of firm-specific productivity equation 12 also holds at the sector level, i.e., relative labor demand per sector is entirely determined by the relative wages paid by firms in that sector. This condition is valid for both sectors.

Firms are heterogeneous in terms of their productivity z_i. The productivity differences across firms translate into differences in the marginal cost of production. Measured in the units of the aggregate consumption good, C_t, the marginal cost of production is $\frac{(w^s_{it})^{\beta_i}\left(w^l_{it}\right)^{1-\beta_i}}{z_i}$.

Prior to entry, firms are identical and face a sunk entry cost f_{et}, which is produced by skilled and unskilled labor, equal to $f_{et}\left(w^s_{it}\right)^{\beta_i}\left(w^l_{it}\right)^{1-\beta_i}$ units of aggregate H consumption. Note that entry costs can differ between sectors due to different factor intensities and due to inter-sectoral wage differentials. Upon entry firms draw their productivity level z_i from a common distribution $G(z_i)$ with support on $[z_{min}, \infty)$. This firm productivity remains fixed thereafter. As in Ghironi and Melitz [2005] there are no fixed costs of production, so that all firms produce each period until they are hit by an exit shock, which occurs with probability $\delta\epsilon(0,1)$ each period. This exit shock is independent of the firm's productivity level, so $G(z)$ also represents the productivity distribution of all producing firms.

Exporting goods to F is costly and involves both an iceberg trade cost $\tau_t \geq 1$ as well as a fixed cost f_{xt}, again measured in units of effective skilled and unskilled labor.[11] In real terms, these costs are $f_{xt}\left(w^s_{it}\right)^{\beta_i}\left(w^l_{it}\right)^{1-\beta_i}$. The fixed cost of

[11] The Iceberg trade costs are proportional to the value of the exported product and represent a number of different barriers to trade. These include both trade barriers that can be influenced by policy, like restrictive product standards or slow processing of imports at the border, and

exporting implies that not all firms find it profitable to export.

All firms face a residual demand curve with constant elasticity in both H and F. They are monopolistically competitive and set prices as a proportional markup $\frac{\theta}{\theta-1}$ over marginal cost. Let $p_{d,it}(z)$ and $p_{x,it}(z)$ denote the nominal domestic and export prices of a H firm in sector i. We assume that the export prices are denominated in the currency of the export market and have to be adjusted for the consumption-based real exchange rate Q_t, defined in terms of units of home consumption per unit of foreign consumption adjusted for the nominal exchange rate e, i.e., $Q_t \equiv eP_t^*/P_t$. We also assume that consumption in each country is subject to sector-specific consumption taxes χ_{it}^c for country H and χ_{it}^{*c} for country F. Prices in real terms, relative to the price index in the destination market are then given by:

$$\rho_{d,it}(z) = \frac{p_{d,it}(z)}{P_t} = (1+\chi_{it}^c)\frac{\theta}{\theta-1}\frac{(w_{it}^s)^{\beta_i}\left(w_{it}^l\right)^{1-\beta_i}}{z_{it}} \tag{13}$$

$$\rho_{x,it}(z) = \frac{p_{x,it}(z)}{P_t^*} = \frac{1}{Q_t}(1+\chi_{it}^{*c})\tau_t\frac{\theta}{\theta-1}\frac{(w_{it}^s)^{\beta_i}\left(w_{it}^l\right)^{1-\beta_i}}{z_{it}}. \tag{14}$$

Profits, expressed in units of the aggregate consumption good of the firm's location are $d_{it}(z) = d_{d,it}(z) + d_{x,it}(z)$, where $d_{d,it}(z)$ and $d_{x,it}(z)$ are after-tax profits, subject to a sector-specific profit tax χ_{it}^p, so that

$$d_{d,it}(z) = (1-\chi_{it}^p)\frac{1}{\theta}\left(\frac{\rho_{d,it}(z)}{\psi_{it}}\right)^{1-\theta}\alpha_i C_t \tag{15}$$

$$d_{x,it}(z) = \begin{cases} (1-\chi_{it}^p)\left[\frac{Q_t}{\theta}\left(\frac{\rho_{x,it}(z)}{\psi_{it}^*}\right)^{1-\theta}\alpha_i C_t^* - f_{xt}\left(w_{it}^s\right)^{\beta_i}\left(w_{it}^l\right)^{1-\beta_i}\right], & \text{if firm z exports} \\ 0 & \text{otherwise.} \end{cases} \tag{16}$$

A firm will export if and only if it earns non-negative profits from doing so. For H firms, this will be the case if their productivity draw z is above some cutoff level $z_{x,it} = \inf\{z : d_{x,it} > 0\}$. We assume that the lower bound productivity z_{min} is identical for both sectors and low enough relative to the fixed costs of exporting so that $z_{x,it}$ is above z_{min}. Firms with productivity between z_{min} and $z_{x,it}$, serve only their domestic market.

3.3.1 Firm Averages

In every period a mass $N_{d,it}$ of firms produces in sector i of country H. These firms have a distribution of productivity levels over $[z_{min}, \infty)$ given by $G(z)$, which is identical for both sectors and both countries. The number of exporters is $N_{x,it} = [1 - G(z_{x,it})]\, N_{d,it}$. It is useful to define two average productivity levels, an average $\tilde{z}_{d,it} = \left[\int_{z_{min}}^{\infty} z^{\theta-1} dG(z)\right]^{\frac{1}{(\theta-1)}}$ for all producing firms in sector i of country H and an average $\tilde{z}_{x,it} = \left[\int_{z_{x,it}}^{\infty} z^{\theta-1} dG(z)\right]^{\frac{1}{(\theta-1)}}$ for all exporters in sector i of country H. As in Melitz [2003], these average productivity levels summarize all the necessary information about the productivity distributions of firms.

We can redefine all the prices and profits in terms of these average productivity levels. The average nominal price of H firms in the domestic market is $\tilde{p}_{d,it} = p_{d,it}(\tilde{z}_{d,it})$ and in the foreign market is $\tilde{p}_{x,it} = p_{x,it}(\tilde{z}_{x,it})$. The price index for sector i in H reflects prices for the $N_{d,it}$ home firms and F's exporters to H. Then, the price index for sector i in H can be

trade barriers that cannot be influenced by policy, like the costs of transportation. We follow the standard practice in the literature and model trade liberalization as a decrease in the Iceberg trade cost.

written as $P_{it} = \left[N_{d,it}\left(\tilde{p}_{d,it}\right)^{1-\theta} + N^*_{x,it}\left(\tilde{p}^*_{x,it}\right)^{1-\theta}\right]$. Written in real terms of aggregate consumption units this becomes $\psi_{it} = \left[N_{d,it}\left(\tilde{\rho}_{d,it}\right)^{1-\theta} + N^*_{x,it}\left(\tilde{\rho}^*_{x,it}\right)^{1-\theta}\right]$, where $\tilde{\rho}_{d,it} = \rho_{d,it}(\tilde{z}_{d,it})$ and $\tilde{\rho}^*_{x,it} = \rho^*_{x,it}(\tilde{z}^*_{x,it})$ are the average relative prices of H's producers and F's exporters.

Similarly we can define $\tilde{d}_{d,it} = d_{d,it}(\tilde{z}_{d,it})$ and $\tilde{d}_{x,it} = d_{x,it}(\tilde{z}_{x,it})$ such that $\tilde{d}_{it} = \tilde{d}_{d,it} + [1 - G(z_{x,it})]\,\tilde{d}_{x,it}$ are average total profits of H firms in sector i.

3.3.2 Firm Entry and Exit

In every period there is an unbounded mass of prospective entrants in both sectors and both countries. These entrants are forward looking and anticipate their future expected profits. We assume that entrants at time t only start producing at time t+1, which introduces a one-period time-to-build lag in the model. The exogenous exit shock occurs at the end of each period, after entry and production. Thus, a proportion δ of new entrants will never produce. Prospective entrants in sector i in H in period t compute their expected post-entry value given by the present discounted value of their expected stream of profits $\{\tilde{d}_{is}\}_{s=t+1}^{\infty}$, so that $\tilde{v}_{it} = E_t \sum_{s=t+1}^{\infty}\left[\gamma^{s-t}(1-\delta)^{s-t}\left(\frac{C_s}{C_t}\right)^{-1}\tilde{d}_{is}\right]$.

This also corresponds to the average value of incumbent firms after production has occurred. Firms discount future profits using the household's stochastic discount factor, adjusted for the probability of firm survival $1-\delta$. Entry occurs until the average firm value is equal to the entry cost. We assume that the government can subsidize firm entry with a sector specific entry subsidy χ^e_{it}, so that the free entry condition is

$$\tilde{v}_{it} = (1 - \chi^e_{it})\, f_{et}\left(w^s_{it}\right)^{\beta_i}\left(w^l_{it}\right)^{1-\beta_i}. \tag{17}$$

Finally, the number of firms evolves according to the following law of motion, $N_{d,it} = (1-\delta)(N_{d,it-1} + N_{e,it-1})$.

3.3.3 Parametrization and Productivity Draws

Productivity z follows a Pareto distribution with lower bound z_{min} and shape parameter $k > \theta - 1$: $G(z) = 1 - \left(\frac{z_{min}}{z}\right)^k$. Let $\nu = \left\{\frac{k}{[k-(\theta-1)]}\right\}^{\frac{1}{\theta-1}}$, then average productivities are $\tilde{z}_{d,it} = \nu z_{min}$ and $\tilde{z}_{x,it} = \nu z_{x,it}$. The share of exporting firms in sector i in H is $\frac{N_{x,it}}{N_{d,it}} = 1 - G(z_{x,it}) = 1 - \left(\frac{\nu z_{min}}{\tilde{z}_{x,it}}\right)^k$. Together with the zero export profit condition for the cutoff firm, $d_{x,it}(z_{x,it}) = 0$, this implies that average export profits must satisfy $\tilde{d}_{x,it} = (\theta-1)\left(\frac{\nu^{\theta-1}}{k}\right) f_{xt}\left(w^s_{it}\right)^{\beta_i}\left(w^l_{it}\right)^{1-\beta_i}$.

3.4 Government

We assume that the government budget is balanced at all times. The simulation experiments that we analyze in section 5 use different configurations of policy instruments which means that the government budget constraint varies depending on the configuration. In our benchmark simulation where all taxes and subsidies are exogenous and zero we do not need a government budget constraint. In the other scenarios we usually pick a combination of two policy instruments and treat one as an exogenous variable and the other as an endogenous variable that balances out the government budget. To avoid repetition we do not write the government budget constraint pertaining to each simulation here but only in section 5. Instead, here we define the different sources of revenue and expenditure of the government.

The government obtains revenue from consumption taxes, profit taxes and wage taxes. The revenue from the consumption tax in sector i consists of the tax proceeds on both domestically produced and imported varieties $\frac{\chi^c_{it}}{1+\chi^c_{it}} N_{d,it} \left(\frac{\tilde{\rho}_{d,it}}{\tilde{\psi}_{it}}\right)^{1-\theta} \alpha_i C_t$ $+\frac{\chi^c_{it}}{1+\chi^c_{it}} N^*_{x,it} \left(\frac{\tilde{\rho}^*_{x,it}}{\tilde{\psi}_{it}}\right)^{1-\theta} \alpha_i C_t$. The revenue from the profit tax in sector i is $\frac{\chi^p_{it}\tilde{d}_{it}}{1-\chi^p_{it}} N_{d,it}$. The revenue from the wage tax in sector i is $\chi^s_{it} w^s_i S_{it}$ for the skilled workers and $\chi^l_{it} w^l_{it} L_{it}$ for the unskilled workers.

The government can spend its revenue on firm entry subsidies, migration subsidies and training subsidies. The expenditures for the firm entry subsidy in sector i are $\chi^e_{it} f_{et} \left(w^s_{it}\right)^{\beta_i} \left(w^l_{it}\right)^{1-\beta_i} N_{e,it}$. The expenditures for the migration subsidy for skilled workers who want to switch from sector i to j is calculated as the difference between total migration costs $\int_{\varepsilon^s_{\min}}^{1/\bar{\varepsilon}^s_t} \frac{\varepsilon^s_t - 1}{\varepsilon^s_t} V^s_{jt} dF\left(\varepsilon^s_t\right) S_{i,t}$ and the migration costs borne by the worker $\int_{\varepsilon^s_{\min}}^{1/\bar{\varepsilon}^s_t} \frac{\left(1-\chi^{mS}_{ijt}\right)\varepsilon^s_t - 1}{\left(1-\chi^{mS}_{ijt}\right)\varepsilon^s_t} V^s_{jt} dF\left(\varepsilon^s_t\right) S_{i,t}$, which yields $\int_{\varepsilon^s_{\min}}^{1/\bar{\varepsilon}^s_t} \frac{\chi^{mS}_{ijt}}{\left(1-\chi^{mS}_{ijt}\right)\varepsilon^s_t} V^s_{jt} dF\left(\varepsilon^s_t\right) S_{i,t}$. Similarly, the expenditure for the migration subsidy for unskilled workers who want to switch from sector i to j is $\int_{\varepsilon^l_{\min}}^{1/\bar{\varepsilon}^l_t} \frac{\chi^{mL}_{ijt}}{\left(1-\chi^{mL}_{ijt}\right)\varepsilon^l_t} V^l_{jt} dF\left(\varepsilon^l_t\right) L_{i,t}$. Finally, the expenditures for the training subsidy for unskilled workers in sector i is $\int_{\pi\varepsilon^s_{\min}}^{\bar{\varepsilon}^i_t} \frac{\chi^t_{it}}{\left(1-\chi^t_{it}\right)\varepsilon^i_t} V^s_{it} dF\left(\varepsilon^i_t\right) L_{i,t}$.

3.5 Aggregate accounting and International Trade

In each sector the total value of production is distributed among three parties, the private households, the domestic government and the foreign government:

$$
\begin{aligned}
&N_{d,it} \left(\frac{\tilde{\rho}_{d,it}}{\tilde{\psi}_{it}}\right)^{1-\theta} \alpha_i C_t + Q_t N_{x,it} \left(\frac{\tilde{\rho}_{x,it}}{\tilde{\psi}^*_{it}}\right)^{1-\theta} \alpha_i C^*_t + f_{et} \left(w^s_{it}\right)^{\beta_i} \left(w^l_{it}\right)^{1-\beta_i} N_{e,it} = \\
&(1-\chi^s_{it}) w^s_i S_{it} + (1-\chi^s_{it}) w^l_{it} L_{it} + \tilde{d}_{it} N_{d,it} + \\
&\frac{\chi^c_{it}}{1+\chi^c_{it}} N_{d,it} \left(\frac{\tilde{\rho}_{d,it}}{\tilde{\psi}_{it}}\right)^{1-\theta} \alpha_i C_t + \chi^s_{it} w^s_i S_{it} + \chi^s_{it} w^l_{it} L_{it} + \frac{\chi^p_{it}\tilde{d}_{it}}{1-\chi^p_{it}} N_{d,it} + \chi^e_{it} f_{et} \left(w^s_{it}\right)^{\beta_i} \left(w^l_{it}\right)^{1-\beta_i} N_{e,it} + \\
&Q_t \frac{\chi^{*c}_{it}}{1+\chi^{*c}_{it}} N_{x,it} \left(\frac{\tilde{\rho}_{x,it}}{\tilde{\psi}^*_{it}}\right)^{1-\theta} \alpha_i C^*_t.
\end{aligned} \tag{18}
$$

Total production is in the first line (including the production of new firms), the income of the private sector (including wage and dividend income) is in the second line, the tax income of the domestic government is in the third line and the tax income of the foreign government is in the fourth line.

Equilibrium conditions under financial autarky imply that the net supply of real risk-free bonds equals zero, so that $B_{t+1} = B_t = 0$ and that the net supply of shares in firms is fixed, so that $x_{it+1} = x_{it} = 1$. Financial autarky also implies balanced trade so that the value of H exports after consumption taxes must equal the value of F exports after consumption taxes, such that

$$
\begin{aligned}
&\frac{1}{1+\chi^{*c}_{1t}} Q_t N_{x,1t} \left(\frac{\tilde{\rho}_{x,1t}}{\tilde{\psi}^*_{1t}}\right)^{1-\theta} \alpha^* C^*_t + \frac{1}{1+\chi^{*c}_{2t}} Q_t N_{x,2t} \left(\frac{\tilde{\rho}_{x,2t}}{\tilde{\psi}^*_{2t}}\right)^{1-\theta} (1-\alpha^*) C^*_t = \\
&\frac{1}{1+\chi^c_{1t}} N^*_{x,1t} \left(\frac{\tilde{\rho}^*_{x,1t}}{\tilde{\psi}_{1t}}\right)^{1-\theta} \alpha C_t + \frac{1}{1+\chi^c_{2t}} N^*_{x,2t} \left(\frac{\tilde{\rho}^*_{x,2t}}{\tilde{\psi}_{2t}}\right)^{1-\theta} (1-\alpha) C_t.
\end{aligned} \tag{19}
$$

4 Parametrization

This section describes the parametrization of the model that we use for the numerical simulations. In most aspects we follow Ghironi and Melitz [2005] and Bernard et al. [2007]. A full list of the parameters and their values is provided in table 1. We interpret each period as a quarter and, set the household discount rate γ to 0.99, the standard choice for quarterly business cycle models. We set the elasticity of substitution between varieties to $\theta = 3.8$, based on the estimates from plant-level U.S. manufacturing data in Bernard et al. [2003]. In order to avoid asymmetry due to demand effects, we set the share of each good in consumer expenditures equal to ($\alpha_1 = \alpha_2 = 0.5$). We set the parameters of the Pareto distribution to $z_{\min} = 1$ and $k = 3.4$, respectively. This choice satisfies the condition for finite variance of log productivity: $k > \theta - 1$.

Changing the sunk cost of firm entry f_e only re-scales the mass of firms in an industry. Thus, without loss of generality we can normalize it so that $f_e = 1$. We set the fixed cost of exporting f_x to 23.5 percent of the per-period, amortized flow value of the sunk entry costs, $[1-\gamma(1-\delta)]/\ [\gamma(1-\delta)]f_e$. This leads to a steady state share of exporting firms of 21 percent. We set the size of the exogenous firm exit probability to $\delta = 0.025$, to match the level of 10 percent job destruction per year in the US. These choices of parameter values are based on Ghironi and Melitz [2005].

To focus on comparative advantage, we assume that all industry parameters are the same across industries and countries except factor intensity (β_i). We consider symmetric differences in factor intensities ($\beta_1 = 0.6, \beta_2 = 0.4$). To assure a positive skill premium in both countries, we assume that unskilled labor is more abundant in both countries. The richer country, H, is endowed with more skilled labor than the poorer country, F. Specifically, we assume that $S = 700$ and $L = 1300$ for H and that $S^* = 370$ and $L^* = 1630$ for F. These numbers imply that the share of skilled workers in the whole workforce is 35% for the rich country and 18.5% for the poor country. This is in line with OECD indicators, where the percentage of individuals with tertiary education between the ages of 25 and 64 range from 29% (EU) to 41% (US) for developed countries and from 4% (China) to 14% (Argentina) for developing countries (see table A1.1a in OECD [2013]). We set our share of skilled workers in the F workforce at a value slightly higher than the quoted OECD numbers in order to ensure a feasible post-liberalization steady state in the scenario where we allow for training.[12] In that scenario only the total endowment of labor is fixed at $ENDOW = S_t + L_t = 2000$ and $ENDOW^* = S_t^* + L_t^* = 2000$, while the share of skilled and unskilled workers is determined endogenously. We also assume that the training cost is Pareto distributed and set the training cost of newly entering workers in such a way, that the share of skilled and unskilled workers matches the numbers above, which implies $\varepsilon_{\min}^{i} = 2.17$ and $\varepsilon_{\min}^{*i} = 3.63$. The shape parameter of the training cost distribution is set to $\kappa^{train} = 2$. The parameter π is set to 1.5, so that the minimum training costs faced by incumbent workers are 1.5 higher than the training costs faced by newly entering workers. Implied minimum training costs for incumbent workers are 3.25 at H and 5.45 at F.

Artuç et al. [2010] find that average sector migration costs are large and very dispersed. We assume that the sector migration costs are Pareto distributed and use the same parameters for both countries to assure that our results are not driven by asymmetric parameter choices. We assume that unskilled workers are more mobile than skilled workers by choosing $\varepsilon_{\min}^{s} = 2$ and $\varepsilon_{\min}^{l} = 1.01$. This is in line with a number of empirical studies: Artuç et al. [2010] find that US workers with a college degree face on average higher mobility costs than workers without a college degree; Greenaway et al.

[12] Otherwise, we would end up in a corner solution after trade liberalization.

[2000] as well as Elliott and Lindley [2006b] find that unskilled workers in the UK are much more mobile across sectors than skilled workers; Elliott and Lindley [2006a] confirm this result and argue that this is due to their significant investments in specific human capital. Recent empirical studies on human capital specificity indicate that sector-specific skills are not industry- or occupation-specific but are defined over broader categories of tasks or skills. Poletaev and Robinson [2008] and Gathmann and Schonberg [2010] show that the pattern of individual wage growth is more closely associated with switching over these broadly defined categories than switching between occupations or industries. Gathmann and Schonberg [2010] show that in Germany 19% of the unskilled switch occupations each year as compared to 10% of the skilled. In addition, skilled workers tend to switch to occupations that require a very similar set of skills as their previous occupation while unskilled workers tend to switch to occupations with dissimilar skills. This suggests that on average skilled workers tend to be less mobile due to sector-specific human capital that is not easily transferable across occupations. However, there is also evidence pointing in the opposite direction. Autor et al. [2013b] find that skilled workers in the US are more mobile across sectors, but sectors in their analysis are much more narrowly defined than in our model.

To allow for a clearer interpretation of our results we assume that the pre-liberalization steady state is not distorted by taxes or subsidies. Thus, $\chi^s_{it} = \chi^l_{it} = \chi^c_{it} = \chi^p_{it} = \chi^e_{it} = \chi^{mS}_{it} = \chi^{mL}_{it} = \chi^t_{it} = 0$ in the pre-liberalization steady state.

5 Results

5.1 Introductory thoughts

This section describes how economic policy can change the effects of trade liberalization. There are at least three potential goals that policy makers could follow: i) reduce medium- and long-run wage inequality by reducing the skill premium, the gap between skilled and unskilled wages; ii) reduce short-run wage inequality by reducing inter-sectoral wage inequality; iii) speed up the adjustment after trade liberalization. It should be noted that these goals can and will be in conflict with each other. In general, the policy makers will face a trade off between reducing short-run and long-run wage inequality. Additionally, the wage differential induces workers to migrate. Thus, a policy that reduces these wage differentials can slow down the adjustment process.

The most likely choice to tackle the first goal to reduce the skill premium is to use the wage tax system. Skilled workers earn more than unskilled workers and making the wage tax system more progressive would already redistribute wage income from skilled workers to unskilled workers. Another policy that has an immediate impact on the skill premium are training subsidies. They are meant to increase the number of skilled workers, making them more abundant and, thus, reducing the skill premium. However, since the skill premium depends on the share of skilled and unskilled workers in the labor force, any other policy might also affect the skill premium indirectly.

The second goal to reduce inter-sectoral wage inequality is not as easily tackled by using the wage tax system. Workers in both sectors earn the same wage in steady state. The inter-sectoral wage inequality that follows after trade liberalization might not be large enough and the wage tax system might not be fine-tuned enough to tackle this source of wage inequality. Taxes that can address the goal more easily are taxes that can be made sector-specific, like a consumption tax that can differ between goods or a profit tax that can differ between sectors.

Finally, the third goal to speed up the adjustment process can be tackled by subsidies meant to encourage reallocation

of firms or workers such as entry subsidies for firms, or sector migration subsidies and training subsidies for workers.

In the following we discuss each instrument in turn, focusing on its effects on wages, wage inequality, the speed of adjustment and efficiency. To do so, we consider two different assumptions concerning the mobility of workers across sectors and skill classes. In the first case we assume that the number of skilled workers is exogenously given, a standard assumption in many trade models (see, e.g., Bernard et al. [2007]). In the second case we assume that the number of skilled workers is endogenous, allowing unskilled workers to invest in training to become skilled workers. In both cases we assume that unskilled workers are more mobile across sectors than skilled workers, which is in line with the empirical evidence (see section 4). In our analysis we concentrate on the skill-abundant country.

5.2 Exogenous share of skilled workers

5.2.1 Benchmark: no policy change

Before analyzing the effects of the modeled policy instruments, we describe our benchmark case, which is trade liberalization, modeled as a decrease in the Iceberg trade costs from 30% to 20% without any change in the other policy instruments. We assume that the Iceberg trade costs are the same for both sectors and both countries and restrict our discussion to the variables of most interest. For a more detailed description and a discussion of a broader set of trade liberalization scenarios the reader is referred to Lechthaler and Mileva [2013].

Figure 2 shows the effects of trade liberalization without any change in the other policy instruments. Time, in terms of quarters, is on the horizontal axis, while the vertical axis shows the percent deviations of a specific variable from its value in the pre-liberalization steady state.[13] Because the adjustment to the new steady state takes a very long time, we do not show the whole process but only the first 50 periods. The value of a variable in the post-liberalization steady state is indicated by a dot on the right margin of each panel.

The decrease in trade costs induces both countries to specialize more in the sector where they have comparative advantage. Thus, the skill-abundant country specializes more in the production of the skill-intensive good. This implies higher demand for both capital (in the form of firms) and workers in the exporting sector which produces the skill-intensive good. As a consequence, the number of workers and the number of firms in the exporting sector increase.

However, the reallocation of workers and firms costs time and resources. Firms have invested resources in a specific sector and cannot switch to another sector. The reallocation of firms can only take place via the death of existing firms.[14] Incumbent firms get replaced by newly created firms, which tend to prefer the expanding sector over the shrinking sector. Similarly, workers are potentially restricted by their investments in sector-specific human capital, especially skilled workers. In principle, they could migrate to the other sector but this necessitates re-training costs, which prevent many workers from migrating to the other sector. At the same time, workers constantly retire and get replaced by newly entering workers. Newly entering workers are more flexible in their sectoral choice than incumbent workers and tend to prefer the expanding sector.

This migration behavior has important implications for wages and wage inequality. With the decrease in trade costs, the demand for workers in the exporting sector immediately increases. But quantities are slow to adjust and the shift in

[13] Some variables such as the index for inter-sectoral wage inequality are reported only as deviations from their pre-liberalization steady state value rather than a percent deviation because they are zero at the pre-liberalizations steady state.

[14] Note that in our model the rate of firm death is exogenous while firm entry is endogenous.

demand must be reflected in wages. The wages of workers in the exporting sector increase relative to the wages of workers in the import-competing sector which leads to a sharp increase in inter-sectoral wage inequality in the short run. As more and more workers migrate to the exporting sector, this inter-sectoral wage inequality becomes lower until it vanishes altogether at the new steady state.

The dynamic adjustment of the skill premium is very different. In the short run it changes very little because the increased demand in the exporting sector benefits both skilled and unskilled workers. In the import-competing sector the skill premium even decreases in the very short run because unskilled workers are faster to migrate away from the import-competing sector. Due to the complementarity of unskilled and skilled workers in the production function this decreases the productivity of skilled workers and leads to a brief drop in the skill premium. However, in the long run the increase in demand in the skill-intensive sector implies an increase in the demand for skilled workers, which must lead to a higher skill premium. The diverse development of our wage inequality measures over time, underlines the importance of having a dynamic model.

Note that our model can generate losers of trade liberalization. Although in the short run all wages increase, in the long run the lower demand for the import-competing sector good leads to lower demand for unskilled workers. In this scenario the efficiency gains from trade liberalization which tend to increase the real wages of all workers are not strong enough to overcome the lower demand for unskilled workers, so that the wage of unskilled workers is lower in the steady state after trade liberalization.[15] Not surprisingly, wage inequality also increases very much. The skill premium increases by approximately 15% and the Gini coefficient, our measure of overall wage inequality increases by almost 10%.

It has to be noted, that from an aggregate perspective the slow adjustment to trade liberalization is in fact efficient. Switching sectors and retraining workers is very costly. Therefore, from an efficiency-point of view it makes perfectly good sense that this process is slow. Steady state taxes are assumed to be zero and there are not any externalities in our model. Thus the outcome of the decentralized economy is the same as in the efficient economy.[16]

Although trade liberalization is beneficial from an aggregate perspective (aggregate consumption rises by more than 2%), it also results in a more unequal distribution of wages. Furthermore, the wage incomes of unskilled workers are lower in the post-liberalization steady state. It is, therefore, understandable that there is resistance to trade liberalization in many developed countries as the public wants to preserve equality and unskilled workers want to prevent income losses. This underlines the importance of having a model with heterogeneous workers and comparative advantage which allows to exactly identify the causes for the adverse effects of trade liberalization. We can use our model to pose the question whether economic policy can be used to reduce the adverse effects of trade liberalization. It has to be noted, however, that from an aggregate perspective our model economy is efficient. Thus, any policy that redistributes wage income runs the risk of disturbing the allocation of production factors, thereby reducing efficiency and aggregate consumption.

[15] In Lechthaler and Mileva [2013] we discuss a broader range of trade liberalization scenarios and show that the effects of trade liberalization can be even more adverse when it is restricted to specific sectors or done unilaterally. These scenarios might even lead to temporary wage drops for the skilled workers in the import-competing sector.

[16] This could easily change in the presence of labor market frictions. E.g., in a search and matching model where the Hosios condition is not fulfilled or were unemployed workers receive government-sponsored unemployment benefits, the decentralized economy is no longer efficient.

5.2.2 Wage tax

The first changes in a policy instrument that we consider are changes in the wage tax. It is the instrument that directly affects wages and wage inequality since workers care most about their after-tax wage. A policy using wage taxes to change the distribution of wages can have various goals and might face various restrictions. Therefore, we will consider a number of different scenarios.

Scenario 1. In our first scenario we assume that policy makers have a very ambitious goal: to avoid the long run increase in wage inequality after trade liberalization. This goal can be achieved by raising the tax on skilled workers and using the proceeds of this tax to subsidize the wages of unskilled workers. In our first exercise we assume that the tax is immediately and permanently raised to its new level. This is certainly an extreme exercise but nevertheless useful to explain the workings of this instrument.

Figure 3 illustrates the effects of an increase in the tax on the wages of skilled workers, χ^s, by 2.7 percentage points. The tax on the wages of unskilled workers, χl, is set endogenously to keep the government's budget balanced at all times. The implied government budget constraint is $\chi_t^s \left(w_{1t}^s S_{1t} + w_{2t}^s S_{2t}\right) + \chi_t^l \left(w_{1t}^l L_{1t} + w_{2t}^l L_{2t}\right) = 0$. In the long run this implies that the skill premium returns to its pre-liberalization level. In the short run, however, the skill premium becomes lower than at the pre-liberalization steady state. This is the case because the tax increase is implemented immediately while the increase in the skill premium is very slow to build up.

When looking at the dynamic path of sectoral wages, we see who suffers the most from this redistribution policy. The wage of skilled workers in the import-competing sector falls very persistently compared to the case without taxes. These workers are hit on various fronts. They work in the shrinking import-competing sector. They suffer from a decrease in the number of unskilled co-workers which reduces their productivity. And they suffer from an increase in the wage tax. These effects combined lead to a long-lasting decrease in their after-tax wage. As an alternative to the immediate jump to the new tax level, Figure 16 in the Appendix considers a gradual increase in the tax rate for skilled workers. The figure shows that a gradual increase in the wage tax on skilled workers can avoid the drop in the wage of skilled workers in the import-competing sector, but it cannot avoid the short-run drop in the skill premium.

The results illustrate that a policy that is meant to help unskilled workers to participate in the gains from trade liberalization can have negative 'side-effects'. These negative side effects are only revealed when looking at the disaggregated wage data. Since the wage of skilled workers in the exporting sector still increases, the average wage of skilled workers does not move by much.

There is another notable result revealed in figure 3. While the policy change has huge distributional consequences, it has no impact on the efficiency of the economy. The policy does not affect the movement of workers across sectors and thereby does not affect relative inputs in production. Output and aggregate consumption are the same, with and without the tax change, only the distribution of wages is affected. The reason for this result is simple. In this scenario the number of skilled workers is given exogenously and so cannot be distorted.[17] The decision of whether to migrate between the two sectors depends on the wage differential. Since the taxes affect both sectors in the same way, the migration decision is not affected.

Scenario 2. Next we consider a more modest policy that aims to avoid the long-run decrease in the unskilled wage

[17] This is of course different in the scenario with worker training.

observed in the no-policy scenario. This goal can be achieved by increasing the wage tax on skilled workers by 0.7 percentage points. For the moment we assume that the tax immediately jumps to the new level. Again, we set the wage tax on unskilled workers endogenously to keep the government budget balanced at all times, implying that the unskilled workers are receiving a wage subsidy. The results are illustrated in figure 4.

Naturally, this experiment is much more beneficial for skilled workers. The tax on skilled wages is much smaller, small enough to reduce the long-run skill premium only a little. But even in this scenario the short-run effects are more in favor of the unskilled workers. In the very short run skilled workers in the import-competing sector still suffer decreases in their wage although these losses turn into gains more quickly. Nevertheless, even then the increase in the unskilled wage is relatively greater than the increase in the skilled wage, so that the skill premium in the import-competing sector stays below the pre-liberalization steady state for a very long time.

Although unskilled workers do not earn higher wages in the new steady state, overall they unambiguously gain from trade liberalization. While in the no-policy scenario short-run gains have to be weighed against long-run losses, in this scenario unskilled workers never earn less than in the pre-liberalization steady state and in the short run they earn more.

In the Appendix we present a scenario in which the tax does not jump immediately to the new steady state level but instead only grows gradually. Figure 17 illustrates that this can avoid the decrease in the aggregate skill premium and in the skill premium in the exporting sector, although the skill premium in the importing sector still goes down temporarily.

Scenario 3. So far our experiments with the wage tax were designed to reduce the skill premium. However, our figures reveal that in the short run overall wage inequality is mainly driven by the inter-sectoral wage inequality among skilled workers. A natural way to address this phenomenon would be to redistribute money between skilled workers, although it might be difficult to design the wage tax in such a way.

Figure 5 shows such an experiment. We assume that the wage tax for skilled workers in the exporting sector is increased by 0.5 percentage points and then slowly converges back to its steady state level.[18] The income generated by this tax increase is used to subsidize the wage of skilled workers in the import-competing sector so that the implied government budget constraint is $\chi^s_{1t} w^s_{1t} S_{1t} + \chi^s_{2t} w^s_{2t} S_{2t} = 0$.

Although the reduction in wages for the skilled workers in the exporting sector is relatively low, the increase in the wage in the import-competing sector is substantial. As expected this considerably reduces inter-sectoral wage inequality among skilled workers. However, the effects on overall wage inequality are only minor. The reason is that the wage subsidy shoots up the skill premium in the import-competing sector. Thus, basically one source of wage inequality is substituted by another.

Scenario 4. In our last wage tax scenario we consider a combination of the scenarios simulated above. We assume that the tax on skilled workers is 0.7% higher in the post-liberalization steady state. The income generated by this tax increase is used to subsidize the wage of unskilled workers, which assures that their after-tax wage is not lower in the post-liberalization steady state than in the pre-liberalization steady state. In the short run, though, we allow for differences between the taxes on skilled workers in the two sectors. Specifically, we assume that the tax on skilled workers in the import-competing sector is reduced on impact but then gradually increases towards the long-run target.[19] The tax on skilled workers in the

[18] In all the scenarios with temporary policy changes the post-liberalization steady state does not change. We therefore leave out the dots indicating the post-liberalization steady state.

[19] Since the tax is zero at the pre-liberalization steady state, the skilled workers in the import-competing sector are actually receiving a wage subsidy in the short run which gradually turns into a wage tax in the long run.

exporting sector also slowly increases towards the new long-run target. The tax on unskilled workers is chosen endogenously to keep the government budget balanced at all times such that $\chi^s_{1t} w^s_{1t} S_{1t} + \chi^s_{2t} w^s_{2t} S_{2t} + \chi^l_t \left(w^l_{1t} L_{1t} + w^l_{2t} L_{2t} \right) = 0$.

Figure 6 shows the results. Inter-sectoral wage inequality is considerably reduced. The drop in the skill premium that resulted in the first two scenarios is avoided in this scenario. This has the consequence that overall wage inequality is increased in the short run, but in the medium to long run, overall wage inequality is considerably reduced compared to the benchmark.

5.2.3 Consumption tax

Although the wage tax policy works well to reduce the after-tax skill premium, it is rather questionable whether it can be used to reduce inter-sectoral wage inequality. At the steady state, workers of the same skill level earn the same wage across sectors and the wage differentials out of the steady state are probably too small so that the tax system cannot be fine-tuned to redistribute wage income across sectors. A more plausible route to compensate the import-competing sector for the enhanced competition and to help workers in that sector, is to use consumption taxes that can be easily changed for a specific sector. We analyze the effects of consumption taxes in this section.

Figure 7 shows the effects of a temporary increase in the consumption tax charged on the good produced by the exporting sector by 3.5 percentage points. The tax charged on the good produced by the import-competing sector is used as an endogenous variable to keep the government budget balanced at any time, which implies that consumption in the import-competing sector is subsidized. The implied government budget constraint is then $\frac{\chi^c_{1t}}{1+\chi^c_{1t}} [N_{d,1t} \left(\frac{\tilde{\rho}_{d,1t}}{\tilde{\psi}_{1t}} \right)^{1-\theta} + N^*_{x,1t} \left(\frac{\tilde{\rho}^*_{x,1t}}{\tilde{\psi}_{1t}} \right)^{1-\theta}] \alpha C_t + \frac{\chi^c_{2t}}{1+\chi^c_{2t}} [N_{d,2t} \left(\frac{\tilde{\rho}_{d,it}}{\tilde{\psi}_{it}} \right)^{1-\theta} + N^*_{x,2t} \left(\frac{\tilde{\rho}^*_{x,2t}}{\tilde{\psi}_{2t}} \right)^{1-\theta}] (1-\alpha) C_t = 0$. We have chosen the level of the tax rate so as to dampen the jump in inter-sectoral wage inequality and to smooth out the adjustment of aggregate wage inequality. The change in the tax policy lasts for 20 periods, which corresponds to 5 years. We have chosen this number of periods because it corresponds to the duration of a typical legislative term.

Figure 7 illustrates that economic policy can achieve this goal.[20] Taxing the good of the exporting sector lowers the demand for the exporting good. This reduces the producer price relative to the no-policy scenario although the consumer price is increased. Since producer prices are determined as a markup over wages, wages in the exporting sector are reduced as well. It is the opposite for the import-competing sector where the consumption tax policy raises producer prices and wages. In the initial periods inter-sectoral wage inequality is relatively flat and then it gradually increases. In contrast, inter-sectoral wage inequality jumps up on impact in the scenario without tax adjustment.

However, while smoothing out the adjustment of wage inequality, this policy severely distorts price and wage signals. This does not matter much for the allocation of skilled workers because these workers are less mobile than unskilled workers. The reallocation of skilled workers mainly takes place via the retirement of old workers and their replacement by newly entering workers. Their decisions are forward looking and cannot be reversed. Thus, their reallocation process is slowed down only little by the tax policy.

The reallocation of unskilled workers, however, is changed very much. Unskilled workers are more mobile and react more strongly to wage differentials. The tax policy suppresses the rise in the inter-sectoral wage differential in the

[20] The reader should not be bothered by the discontinuous development of most variables. This is caused by the discrete jumps in the policy instrument and could be avoided by using instead a continuous process for the policy instrument. However, we consider the discrete jump scenario more realistic and thus stick to it.

initial periods after trade liberalization so that the migration of unskilled workers from the import-competing sector to the exporting sector almost stops. Ironically, this policy hurts the skilled workers in the exporting sector the most and benefits the skilled workers in the import-competing sector the most. Skilled workers in the exporting sector have fewer unskilled co-workers which reduces their productivity and wages. At the same time, the skilled workers in the import-competing sector have more unskilled co-workers which raises their productivity and wages. This explains why this policy leads to a flat skill premium in the exporting sector and a slight increase of the skill premium in the import-competing sector - in stark contrast with the scenario without tax policy.

The development in the number of firms does not seem to conform with this. While the consumption tax policy considered in this section reduces the number of workers in the exporting sector relative to the benchmark, the number of firms in the exporting sector actually increases considerably. Why is that? The higher consumption tax leads to lower demand and lower prices, which reduces profits and should deter firm entry. However, at the same time, wages in the exporting sector go down. On the one hand, this dampens the reduction in profits. On the other hand, this reduces entry costs because entry costs are denominated in effective labor units and thus, are determined by wages. It is this reduction in entry costs that leads to an increase in the number of firms in the exporting sector.

Finally, a look at consumption reveals that this kind of policy is actually quite expensive. On impact consumption in the scenario with tax policy is lower than in the benchmark by almost a full percentage point and stays considerably below the benchmark-path for the entire period that the tax change is in effect. The lower consumption relative to the benchmark scenario is explained by the large investment in new firms in the exporting sector.

5.2.4 Profit tax

An alternative way to help the import-competing sector would be to use profit taxes instead of consumption taxes. By temporarily increasing the tax on profits in the exporting sector and using the proceeds of this tax to subsidize the profits in the import-competing sector, the effects of trade liberalization on inter-sectoral inequality can be smoothed out. Figure 8 shows a scenario in which the profit tax in the exporting sector is increased by 2.5 percentage points. The profit tax in the import-competing sector is used as an endogenous variable to keep the government budget balanced at all times such that $\frac{\chi^p_{1t}\tilde{d}_{1t}}{1-\chi^p_{1t}}N_{d,1t} + \frac{\chi^p_{2t}\tilde{d}_{2t}}{1-\chi^p_{2t}}N_{d,2t} = 0$. Again the level of the tax rate is chosen so as to dampen and to smooth the effect of trade liberalization on inter-sectoral wage inequality.

The development of most variables is similar to their development in the previous consumption tax scenario. Wages in the exporting sector are lower than in the benchmark while wages in the import-competing sector are higher. Inter-sectoral wage inequality increases more gradually. Unskilled workers are slower to migrate between sectors which implies that the skill premium in the exporting sector is flat in the first periods after trade liberalization.

There is, however, a notable difference: the development in the number of firms. While the number of firms in the exporting sector was increased by the consumption tax policy, it is considerably decreased by the profit tax policy. The profit tax lowers the after-tax profits that go to investors. In contrast to the consumption tax scenario this is not compensated by a decrease in effective entry costs, so that firm entry must go down in the exporting sector. Note that this scenario is more beneficial than the consumption tax scenario in terms of aggregate consumption: the reduction in consumption in the short run is much lower and accompanied by an increase in consumption in the medium run.

5.2.5 Firm entry subsidy

All the scenarios considered so far have revealed a very slow adjustment in the number of firms. If economic policy would like to speed up this process, a plausible instrument to achieve this would be a subsidy to firms entering the exporting sector. Similarly to the previous scenarios we assume that a tax on entry in the other sector is used to balance the government budget at all times such that $\chi^e_{1t} f_{et} \left(w^s_{1t}\right)^{\beta_1} \left(w^l_{1t}\right)^{1-\beta_1} N_{e,1t} + \chi^e_{2t} f_{et} \left(w^s_{2t}\right)^{\beta_2} \left(w^l_{2t}\right)^{1-\beta_2} N_{e,2t} = 0$. This tax could be justified on the grounds that the number of firms in the import-competing sector must be reduced and a tax on entry could speed up this process. In the Appendix we consider as an alternative assumption that the entry subsidy is financed using a wage tax. Figure 18 in the Appendix illustrates that this does not have a big impact on our results.

Figure 9 shows the effects of a temporary increase (20 periods) in the entry subsidy by 1 percentage point. The subsidy does indeed speed up the entry of firms but only as long as it is active. As soon as the entry subsidy is stopped, the number of firms quickly converges back to the path in the benchmark scenario. Along with the entry of firms in the exporting sector the reallocation of unskilled workers is also accelerated but again after the subsidy is stopped, the number of unskilled workers in the exporting sector quickly converges back to path in the benchmark scenario.

The reason for these developments lies in the forward looking nature of the underlying decisions. Both the entry decision of firms and the migration decision of workers are based on the expectations about future variables, profits in the case of firms and wages in the case of workers. Since a temporary entry subsidy does not affect expectations far into the future, the effects are very short-lived. For the firms, the choice of sector is not associated with any costs, while for the workers, the migration decision is associated with costs. This explains the higher persistence and lower overshooting of the number of unskilled workers compared to the number of firms.

Thus, the temporary subsidy in this scenario fails to speed up the convergence to the new steady state. It only has a temporary effect and leads to a temporary overshooting in the number of firms. With regard to consumption the policy utterly fails to generate a smooth adjustment and leads to large disruptions, higher consumption during the periods of subsidization and a large drop afterward.

As long as the entry subsidy is in effect, it leads to much higher wage inequality. This is driven mostly by an increase in inter-sectoral wage inequality which responds to the larger shift in relative labor demand across sectors. Accelerated entry in the exporting sector leads to a greater demand for workers and higher wages compared to the benchmark. At the same time, slowed down entry in the import-competing sector leads to a lower demand for workers and lower wages compared to the benchmark.

Figure 9 also shows that the wage of skilled workers in the import-competing sector considerably decreases. Recall that the productivity and, hence, the wage of skilled workers decreased with the drop in the number of unskilled workers in the import-competing sector. Since the entry subsidy speeds up the reallocation of unskilled workers from the import-competing sector to the exporting sector, it also leads to a greater decline in the productivity and wages of skilled workers in the import competing sector. Thus, this policy, as sensible as it appears at first thought, can only be called a failure. It does not speed up the adjustment process and considerably increases wage inequality.

5.2.6 Migration subsidy

In the short run most of wage inequality is driven by the inter-sectoral wage inequality among skilled workers that is caused by the low mobility of skilled workers across sectors. Therefore, it seems sensible to subsidize the sectoral migration of these workers. We simulate a scenario in which we give a temporary subsidy of 50 percentage points to skilled workers that migrate from the import-competing sector to the exporting sector. This scenario is illustrated in figure 10.[21] To avoid mixing up the results of the subsidy with the effects of financing the subsidy we assume that it is financed by a proportional tax on all wages, χ, so that $\int_{\varepsilon^s_{\min}}^{1/\bar{\varepsilon}^s_t} \frac{\chi_t^{mS}}{\left(1-\chi_t^{mS}\right)\varepsilon_t^s} V_{2t}^s dF\left(\varepsilon_t^s\right) S_{1,t} + \int_{\varepsilon^s_{\min}}^{\bar{\varepsilon}^s_t} \frac{\chi_t^{mS}}{\left(1-\chi_t^{mS}\right)\varepsilon_t^s} V_{1t}^s dF\left(\varepsilon_t^s\right) S_{2,t} = \chi_t \left(w_{1t}^s S_{1t} + w_{2t}^s S_{2t} + w_{1t}^l L_{1t} + w_{2t}^l L_{2t}\right)$.[22]

Although the migration subsidy lasts for only 20 periods, as did the firm entry subsidy, the effects are much more persistent. The reason is that the migration of skilled workers across sectors is very costly. This makes the process very persistent and hard to reverse. The increased persistence affects future prices and wages and thereby also the migration decision of unskilled workers and the entry decision of firms. For both the reallocation is increased very persistently as a result of the migration subsidy.

As expected this policy decreases sectoral wage inequality among skilled workers considerably and persistently. Skilled workers in the import-competing sector become more scarce while skilled workers in the exporting sector become more abundant. This lowers skilled wages in the exporting sector and raises skilled wages in the import-competing sector and inter-sectoral wage inequality goes down.

At the same time, unskilled wages are lowered in both sectors. In the benchmark scenario unskilled workers were gaining from their relatively higher sectoral mobility compared to skilled workers. Unskilled workers could be set to more efficient uses than skilled workers and this was reflected in higher wages. Subsidizing migration of skilled workers reduces this advantage and thus the wages of unskilled workers relative to the benchmark. This leads to an increase in the aggregate skill premium and the skill premium in the import-competing sector. Thus, although inter-sectoral wage inequality is considerably reduced, overall wage inequality as reflected in the Gini coefficient is actually increased. There seems to be a trade off of the policy makers between speeding up the reallocation of workers and reducing inequality.

Note that the policy also lowers aggregate consumption for a while. This is so because more resources are put into the creation of new firms in the exporting sector. It might seem surprising that the two policies which speed up reallocation at least temporarily do not seem to improve efficiency. The reason is that the decentralized economy is already efficient because it efficiently takes into account the reallocation costs which are a primitive of the economy. By speeding up the process of reallocation the optimal path is left and too many resources are put into reallocation.

5.3 Endogenous share of skilled workers

5.3.1 Benchmark: no policy change

We again start with a description of how the most important variables evolve after a permanent and immediate reduction in the Iceberg trade costs when tax policy does not change. Figure 11 illustrates this case.

[21] To make the persistence of the effects more visible we extend the number of periods shown to 200.

[22] Remember that aggregate labor supply in this model is exogenous, so a tax on all wages is not distortionary.

The first result that strikes the eye is the absence of any notable change in the long-run skill premium and in long-run wage inequality.[23] This difference is explained by the opportunity of workers to train.

In the previous section the supply of skilled workers was fixed exogenously and could not react to the increased demand for skilled workers. Therefore, wages had to go up. In this scenario, the increased demand for skilled workers leads to higher wages only in the short run. In the medium run, the higher wages induce more investment in training. The number of skilled workers increases and thus their wage relative to the unskilled wage drops. In the long run all wage differentials are exploited and thus the skill premium goes back to the old steady state level. While in the scenario with exogenous supply of skilled workers, the increased demand solely shows up in wages, with endogenous supply of skilled workers, the increased demand solely shows up in the quantities (i.e., the number of skilled workers).

Another notable result is the higher path of consumption in this scenario. The endogeneity of skilled workers implies that the economy can react more efficiently to the decrease in trade costs. By increasing the number of skilled workers the opportunities of trade can be better exploited, countries can specialize more in their comparative advantage and output and consumption go up.

So in the long run wage inequality does not increase by much, but in the short run the scenario is similar to the no-training scenario. Inter-sectoral wage inequality increases, the skill premium in the exporting sector increases, the skill premium in the import-competing sector decreases and overall wage inequality increases.

5.3.2 Wage tax

In the no-training scenario trade liberalization implied a permanent increase in the skill premium and unskilled workers suffered a long-run decrease in their wage. To avoid or soften these outcomes permanent changes in the wage tax could be used. In the training scenario, there is no long-run increase in the skill premium and the long-run wage increases for everyone. Thus, in this scenario the argument in favor of tax changes is much weaker, especially for permanent ones. Nevertheless, we think it is interesting to analyze such a scenario as a useful comparison against the results in the no-training scenario and as a warning.

Remember that in the no-training scenario, a tax on wage income that does not differentiate between the two sectors does not distort the economy. The migration/entry decisions are not affected and therefore aggregate output is the same with and without tax. As demonstrated in figure 12, this changes in the training scenario because an increase in the skilled wage reduces the incentives to train. The policy we consider in this graph is equivalent to scenario 2 in section 5.2.2, a permanent increase in the tax on skilled workers' wages that is used to subsidize the unskilled workers' wages. The size of the tax increase is the same as in scenario 2 of that section, 0.7%.

A permanently higher tax on skilled workers permanently decreases the number of skilled workers below the efficient level. As a consequence aggregate consumption in the new steady state lies below the level it had without tax distortion. The wages of all workers are also lower, but only a little. Since the skill premium does not increase in the long run in any case, the effect on overall wage inequality is only marginal. Overall wage inequality slightly decreases because fewer workers enjoy the skill premium.

An interesting implication of this policy is that it lowers the before-tax wages of unskilled workers and raises the

[23] There is a slight increase in overall inequality because more workers earn the skilled wage.

before-tax wages of skilled workers (not depicted). Since the after-tax skill premium does not change, the described tax policy must increase the wedge between the before-tax wages. Looking at the result from this perspective might create the impression that the policy is actually working since it reduces the inequality in before-tax wages. But in fact the policy itself creates the inequality in before-tax wages that it pretends to fight.

In the short run, the policy considerably reduces the skill premium in both sectors, thereby reducing overall wage inequality below the level it had before the liberalization of trade. The number of skilled workers is not only reduced in the long run, the buildup of skilled workers is also considerably slowed down.

Figure 13 considers a temporary change in the wage tax for twenty periods. Knowing that a permanent tax change is harmful, politicians might want to opt for a temporary change in the wage tax to smooth the adjustment after trade liberalization. This kind of policy is short-lived and does not change considerably the forward looking training and migration decisions of workers. The tax policy reduces overall wage inequality in the short run by considerably reducing the skill premium.

5.3.3 Training subsidy

The endogeneity of the training decision opens up the opportunity to analyze an instrument that could not be analyzed in the no-training scenario: training subsidies, which seem to be a popular instrument during the adjustment periods after trade liberalization (see Boix [2011]). We again look at both, temporary and permanent policy changes.

Figure 14 illustrates the effects of a permanent increase in the training subsidy by 35 percentage points, that is financed by a tax on all wages. The implied budget constraint for the government is $\frac{\chi_t^t}{\left(1-\chi_t^t\right)}\ (\int_{\pi\varepsilon_{\min}^1}^{\bar{\varepsilon}_t^1} \frac{V_{1t}^s}{\varepsilon_t^1} dF\left(\varepsilon_t^1\right) L_{1,t} + \int_{\pi\varepsilon_{\min}^2}^{\bar{\varepsilon}_t^2} \frac{V_t^2}{\varepsilon_t^2} dF\left(\varepsilon_t^2\right) L_{2,t}) = \chi_t \left(w_{1t}^s S_{1t} + w_{2t}^s S_{2t} + w_{1t}^l L_{1t} + w_{2t}^l L_{2t}\right)$. Not surprisingly the policy induces a permanent increase in the number of skilled workers. This makes skilled workers more abundant and unskilled workers scarcer so that the skilled wage drops and the unskilled wage rises. Thus, the skill premium is permanently reduced and with it overall wage inequality.

Consumption is higher in this scenario than in the benchmark without subsidies, because the number of skilled workers is higher, but note that this measure does not take account of the training costs, which are paid in the form of disutility. Taking account of this, utility is lower in the new steady state because of inefficient over-investment in training. Thus, the policy succeeds in reducing overall wage inequality, but at the price of lower aggregate utility, although the drop is rather low.

Finally, figure 15 illustrates the effects of a temporary increase in the training subsidy that lasts for 5 years. The training subsidy considerably and persistently increases the number of skilled workers even beyond its period of implementation. The acceleration in the reallocation of skilled workers also speeds up the reallocation of firms. Because of the large and persistent increase in the number of skilled workers, the skill premium and overall wage inequality go down very persistently.

Thus, similar to the effects of migration subsidies in the no-training scenario, training subsidies continue to have an impact much beyond their period of implementation. The reason is that the training decision is a costly, forward looking decision and therefore the process of skilled workers is very persistent. The persistence in the process of skilled workers transmits into persistence for the other variables.

6 Conclusion

This paper has analyzed economic policy in a model of international trade that incorporates comparative advantage, skilled and unskilled workers, firm heterogeneity and endogenous firm entry into a dynamic setting. Our model has the advantage that it allows to track the adjustment process after trade liberalization and that it allows for a rich picture of wage inequality.

In our model, trade liberalization that is not accompanied by other policy interventions leads to a short-run increase in inter-sectoral wage inequality, in the skill premium and in overall wage inequality. What happens in the long run depends on the assumption concerning worker training. If the number of skilled workers is exogenously fixed, then trade liberalization leads to a long-run increase in overall wage inequality. If the number of skilled workers is endogenously determined, by allowing unskilled workers to train, trade liberalization increases overall wage inequality in the long run only very little.

Economic policy in this context can have various goals. It can aim to reduce the skill premium, to reduce inter-sectoral wage inequality or to speed up the adjustment process. The policy instruments that we have considered to reach these goals are wage taxes, consumption taxes, profit taxes, firm entry subsidies, migration subsidies and training subsidies.

We have shown that wage taxes can be a powerful instrument to reduce the skill premium, but they have the disadvantage of overly hurting the skilled workers in the import-competing sector and they can be quite harmful from an aggregate perspective if they distort the incentives to invest in training.

Consumption taxes and profit taxes are a potent instrument to reduce inter-sectoral wage inequality and they lead to a smoother adjustment in wage inequality after trade liberalization. Entry subsidies are a quite expensive instrument that speeds up the adjustment process only very little while it increases wage inequality in the short run. Migration subsidies to skilled workers speed up the adjustment process more persistently but they hurt the unskilled workers.

Probably the most potent instrument to fight wage inequality is the subsidization of worker training. By increasing the number of skilled workers this policy raises output in the long run and in the short run and it reduces the skill premium and with it overall wage inequality in the short run. The policy comes at the cost of over-investment in worker training but the ensued welfare loss is rather minor.

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7 Tables and Figures

Table 1		
Parameter	Description	Value
α	share of skill-intensive good in household consumption	0.5
γ	household discount factor	0.99
θ	elasticity of substitution between varieties	3.8
δ	probability of firm exit	0.025
$z_{\min}$	minimum value of firm productivity	1
k	shape parameter for firm Pareto distribution	3.4
β_1	skilled labor intensity parameter	0.6
β_2	unskilled labor intensity parameter	0.4
S	endowment with skilled labor at Home	700
L	endowment with unskilled labor at Home	1300
S^*	endowment with skilled labor at Foreign	370
L^*	endowment with unskilled labor at Foreign	1630
s	retirement rate of workers	0.02
$\varepsilon^s_{\min}$	minimum sector migration cost for skilled labor	2
$\varepsilon^l_{\min}$	minimum sector migration cost for unskilled labor	1.01
κ	Pareto shape parameter for sector migration cost distribution	2
$\varepsilon^i_{\min}$	minimum cost of training at Home	2.17
$\varepsilon^{*i}_{\min}$	minimum cost of training at Foreign	3.63
κ^{train}	Pareto shape parameter of training cost distribution	2
π	parameter for minimum training costs on incumbent unskilled workers	1.5
f_x	fixed cost of exporting at Home	$0.235[1-\beta(1-\delta]/[\beta(1-\delta)]f_e$
f^*_x	fixed cost of exporting at Foreign	$0.235[1-\beta(1-\delta)]/[\beta(1-\delta)]f^*_e$
f_e	fixed entry cost at Home	1
f^*_e	fixed entry cost at Foreign	1
τ	iceberg trade cost at Home	1.3
τ^*	iceberg trade cost at Foreign	1.3

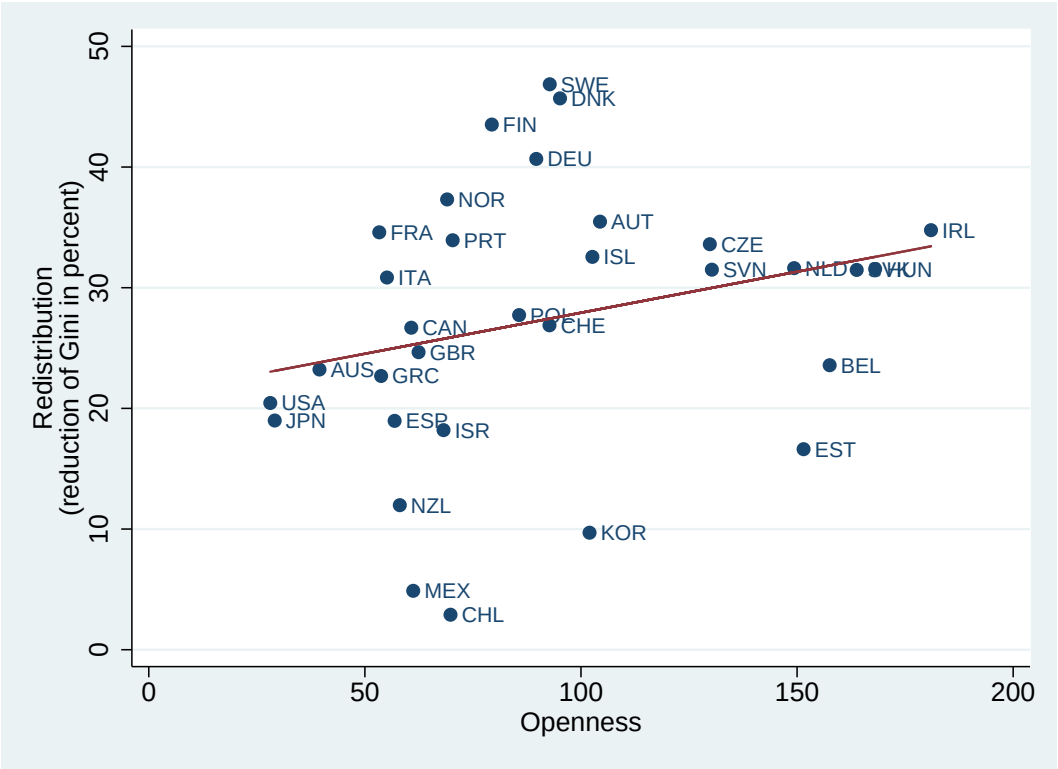

Figure 1:
Openness and Redistribution

A scatter plot for OECD countries suggests a positive relationship between openness and redistribution. Openness is on the horizontal axis measured as the sum of exports and imports divided by nominal GDP. Redistribution is on the vertical axis measured as the difference between a Gini index based on market income and a Gini index based on net income. The measure of redistribution is based on a data set put together by Solt [2009]. The solid line is based on a linear regression between openness and redistribution, where

$$\underset{}{\textit{Redistribution}} = \underset{(3.598)}{21.13} + \underset{(.029)}{0.068}\ \textit{Openness}$$

with robust standard errors in the parentheses. The coefficient is significant at the 5% level. The data sample includes all OECD countries except Luxenmburg and dates to 2010.

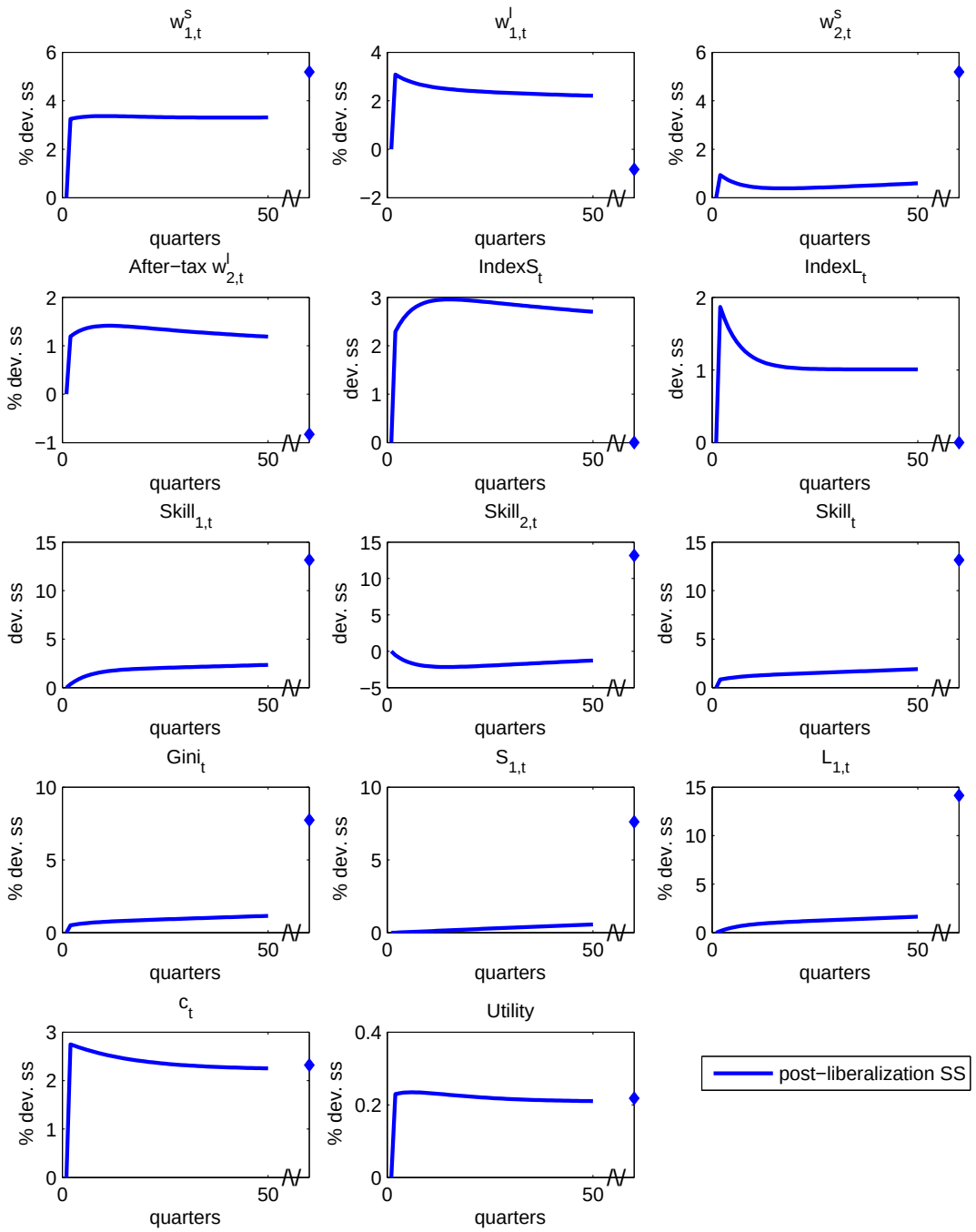

Figure 2:
Benchmark scenario without training
Iceberg trade costs fall from 1.3 to 1.2

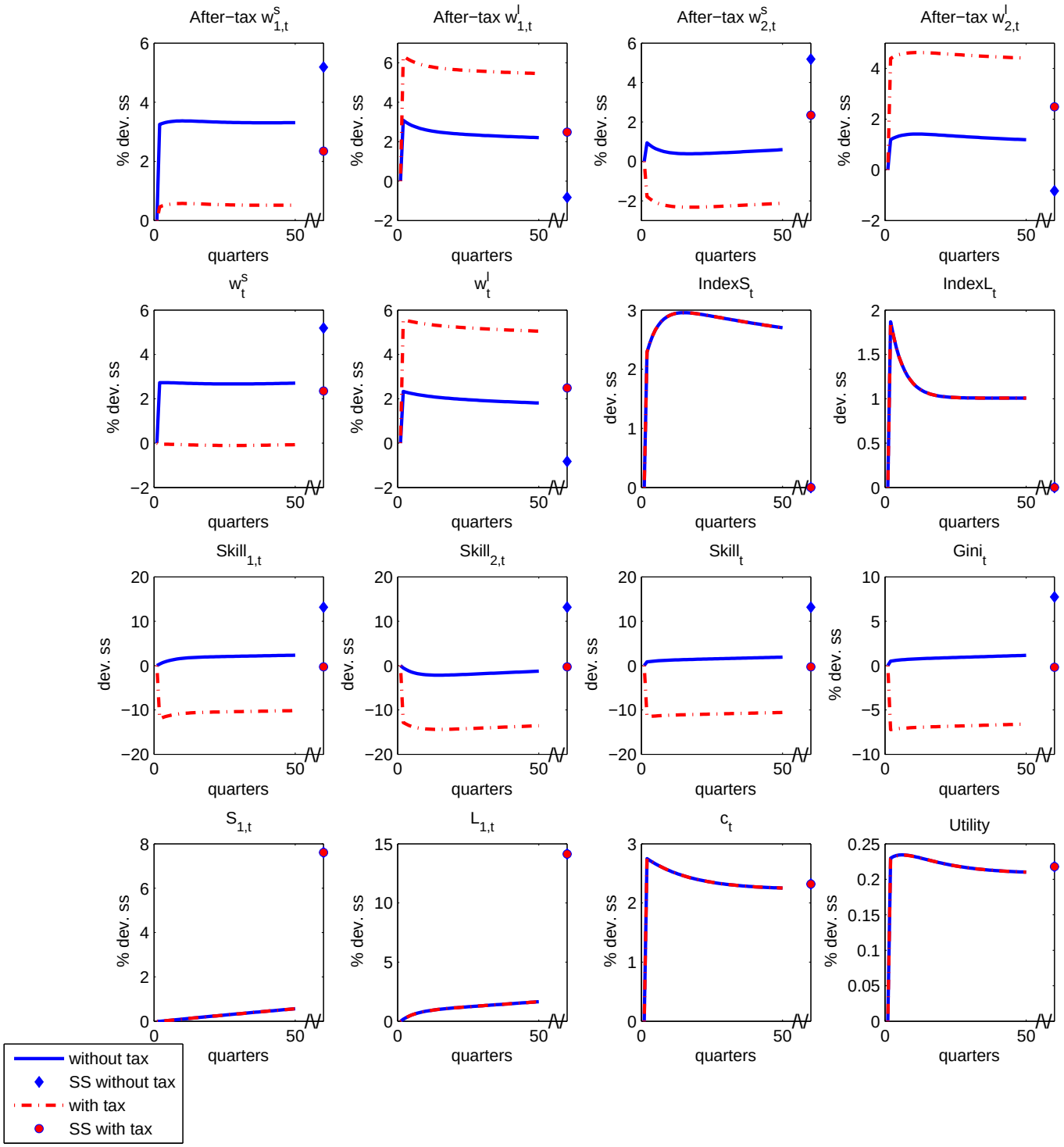

Figure 3:
Permanent wage tax on skilled labor financing wage subsidy on unskilled labor
Tax on skilled rises by 2.7 percentage points.

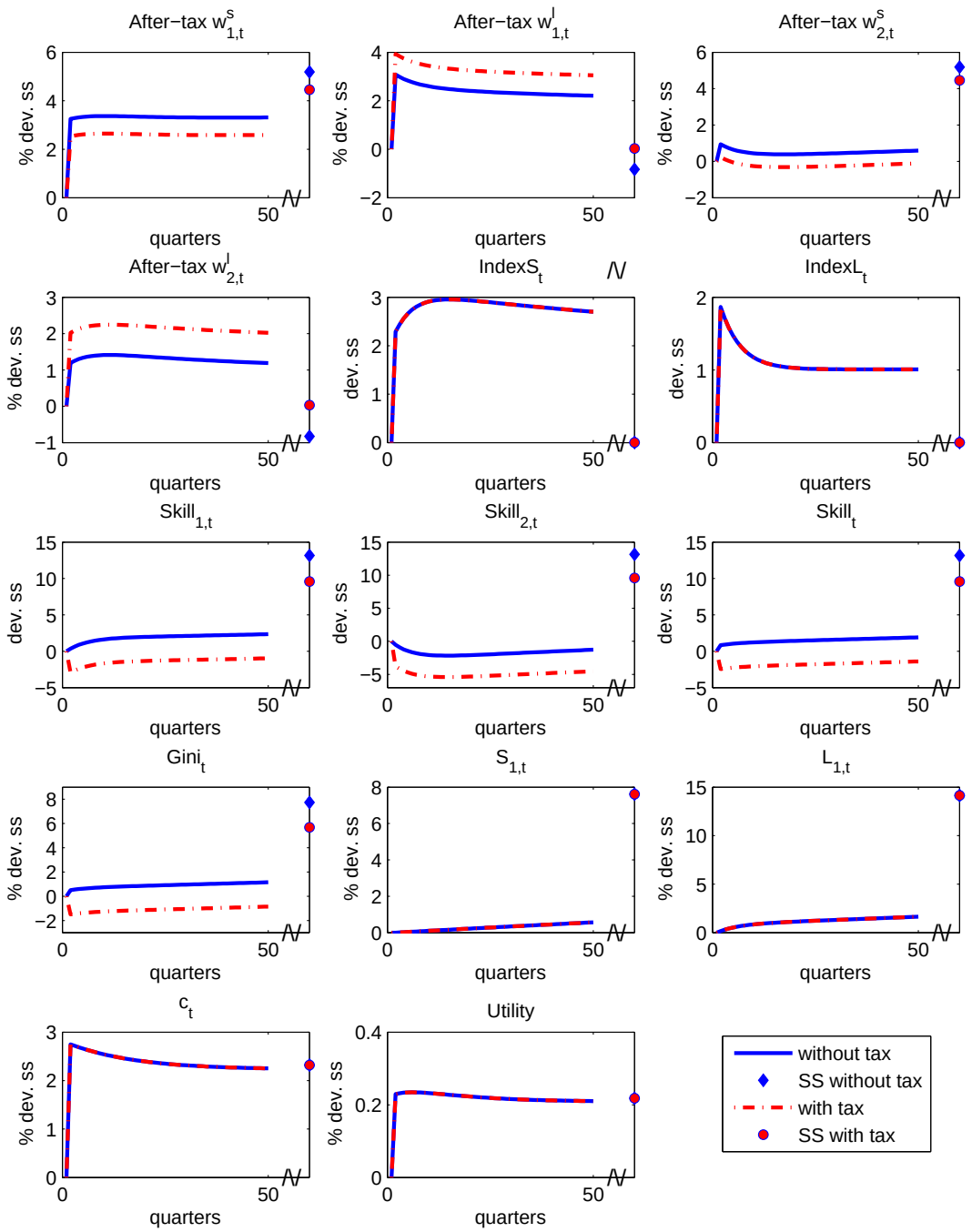

Figure 4:
Permanent wage tax on skilled labor financing wage subsidy on unskilled labor
Tax on skilled rises by 0.7 percentage points

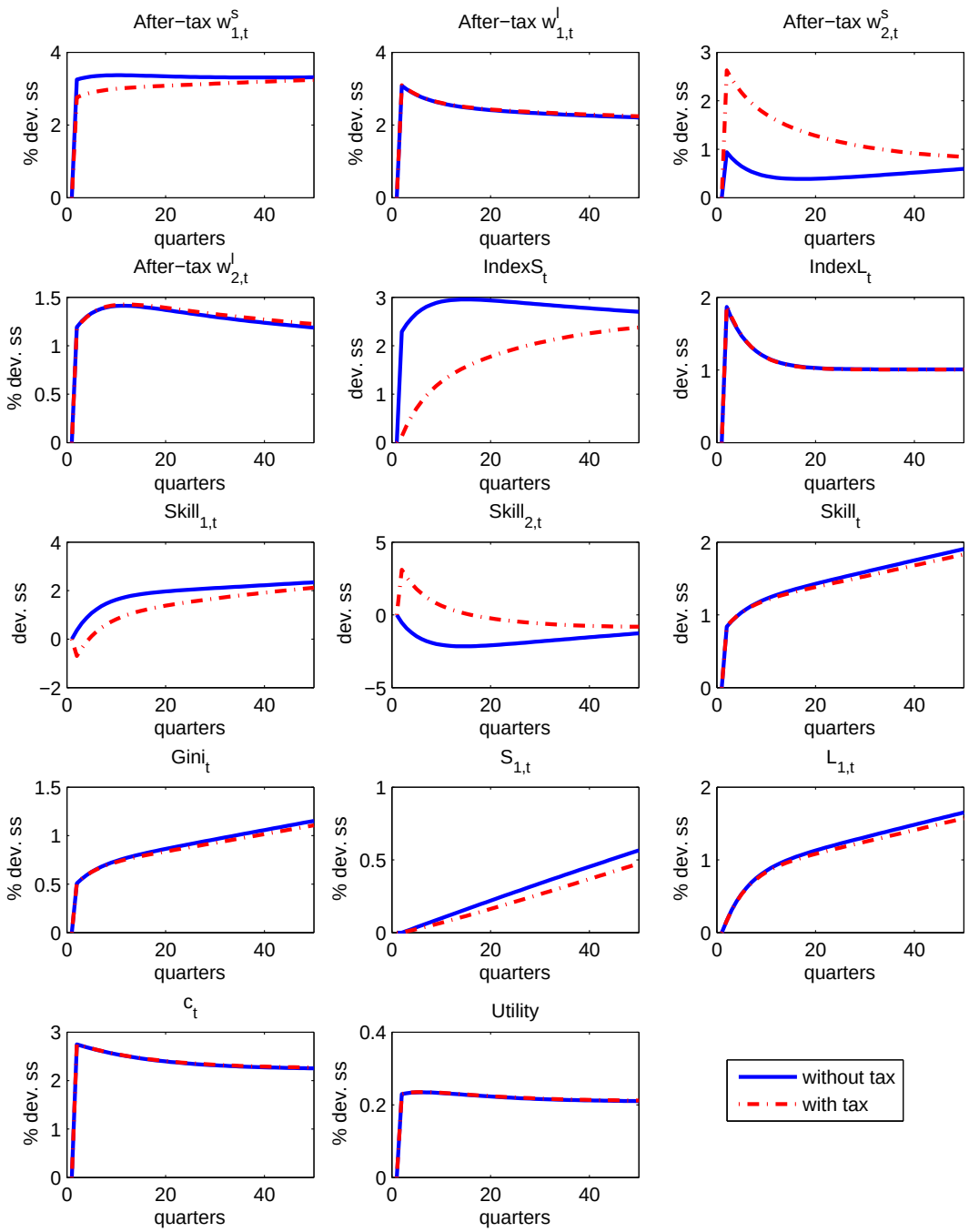

Figure 5:
Temporary wage tax on skilled labor in sector 1 financing wage subsidy on skilled labor in sector 2
Exogenous tax process on skilled in period t: $tax_t = 0.97^t tax_0$with $tax_0 = 0.005$

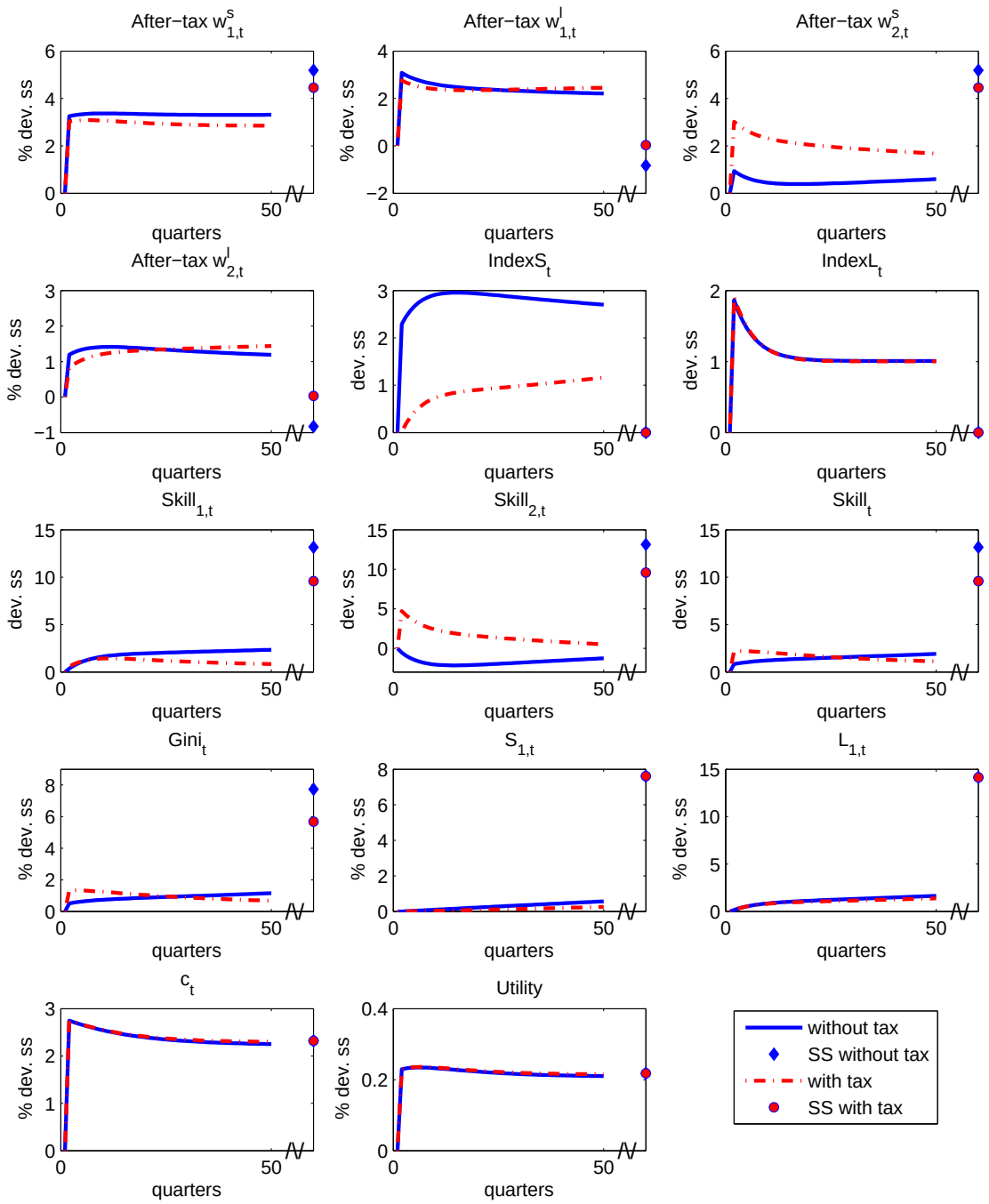

Figure 6:
Temporary wage tax on skilled labor in sector 1 financing wage subsidy on skilled labor in sector 2
Exogenous tax process on skilled in sector 1 in period t: $tax_t = -0.97^t tax_0 + 0.007$ with $tax_0 = 0.007$
Exogenous tax process on skilled in sector 2 in period t: $tax_t = -0.997^t tax_0 + 0.007$ with $tax_0 = -0.021$

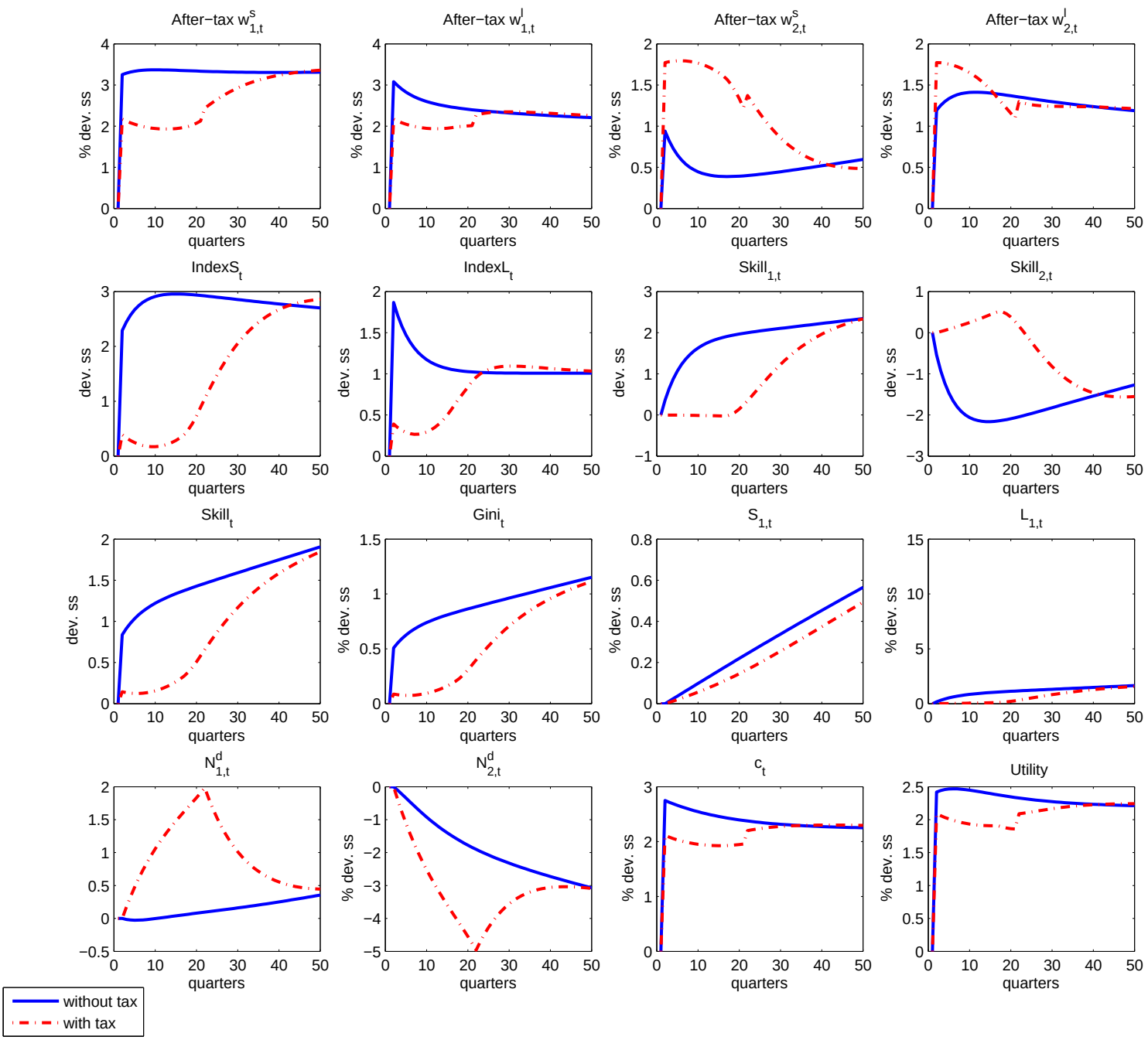

Figure 7:
Temporary consumption tax on in sector 1 financing consumption subsidy in sector 2
Tax in sector 1 rises by 3.5 percentage points for 20 periods

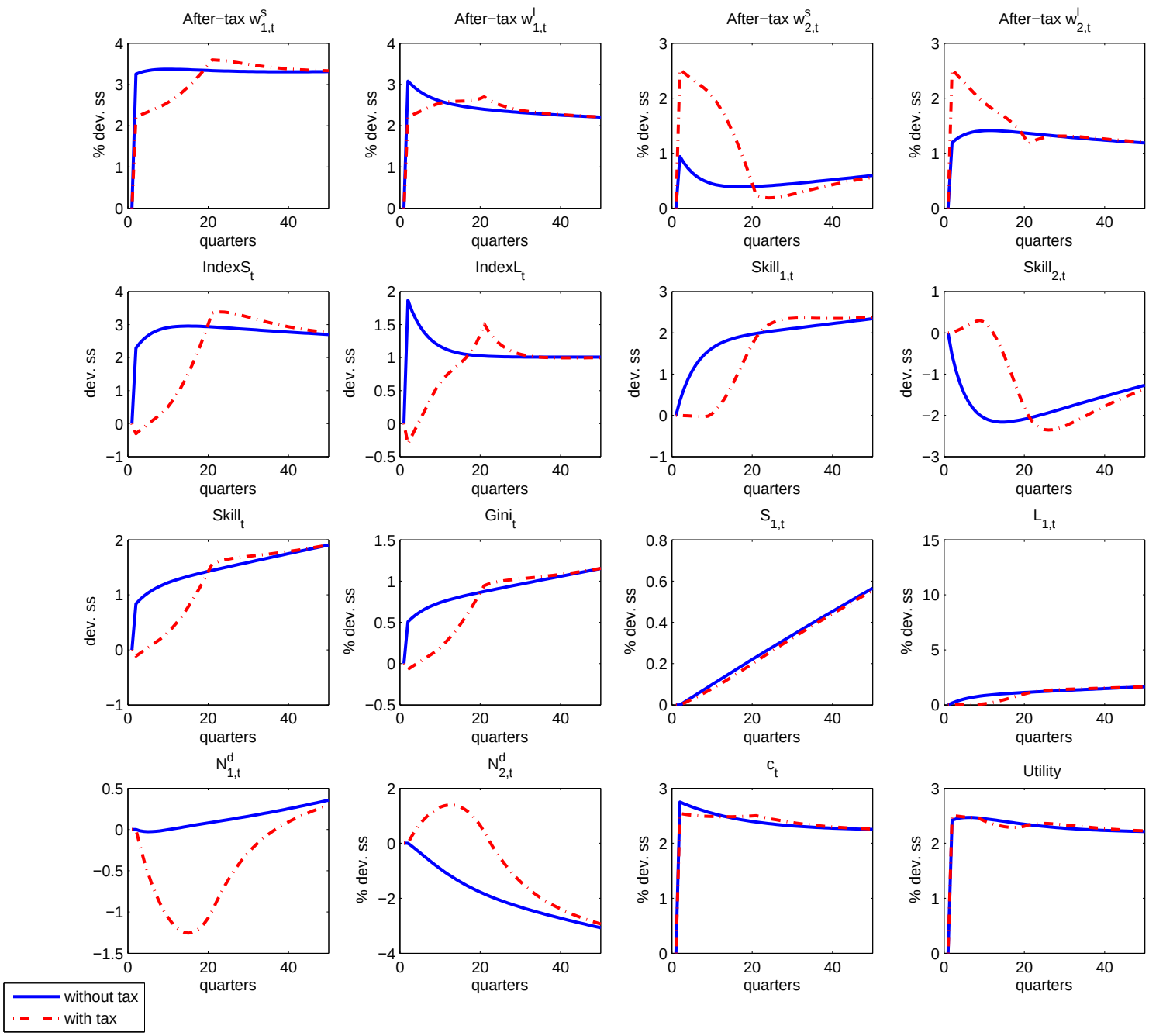

Figure 8:
Temporary profit tax on in sector 1 financing profit subsidy in sector 2
Tax in sector 1 rises by 2.5 percentage points for 20 periods

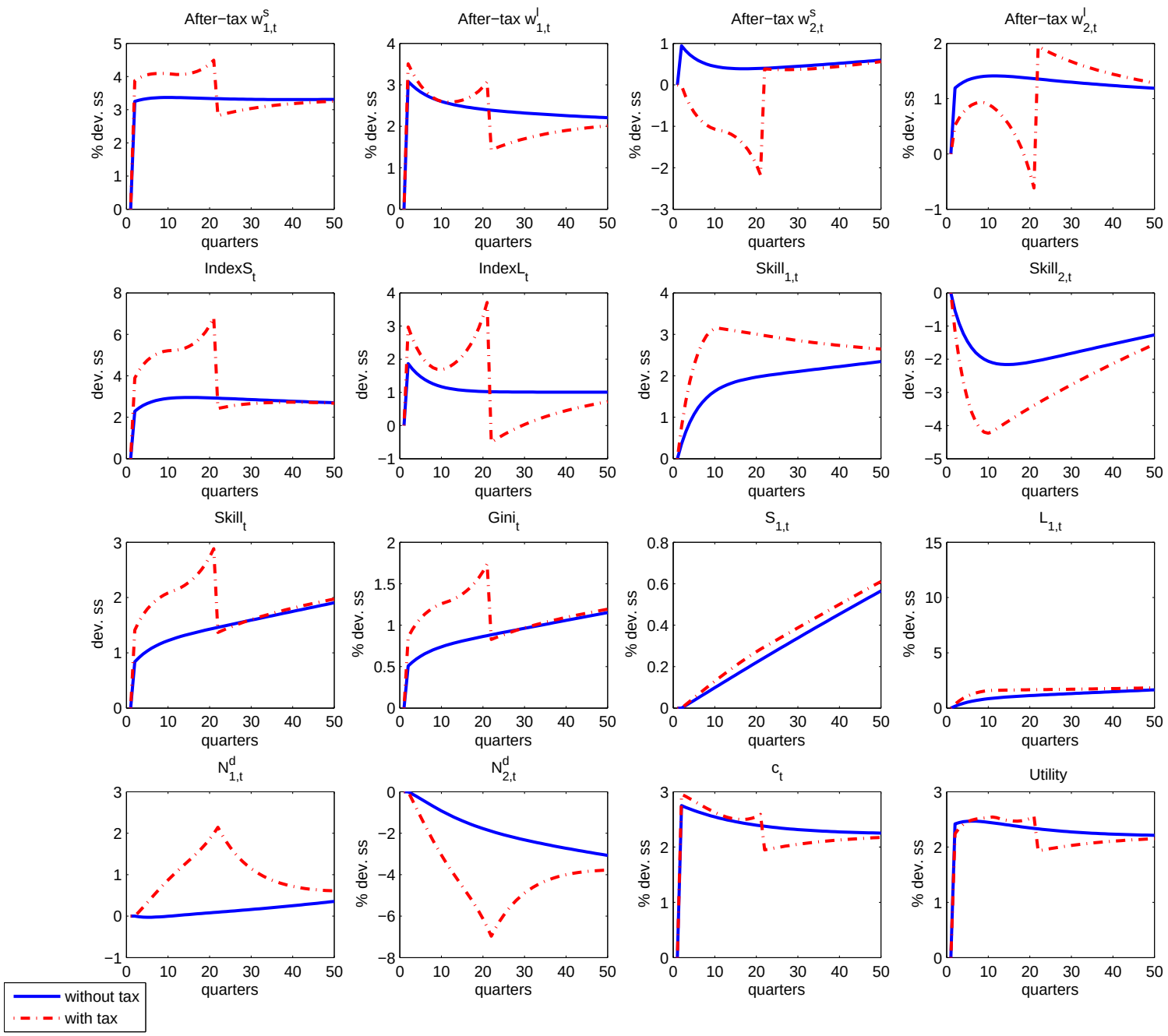

Figure 9:
Temporary firm entry subsidy in sector 1 financed by firm entry subsidy in sector 2
Subsidy in sector 1 rises by 1 percentage point for 20 periods

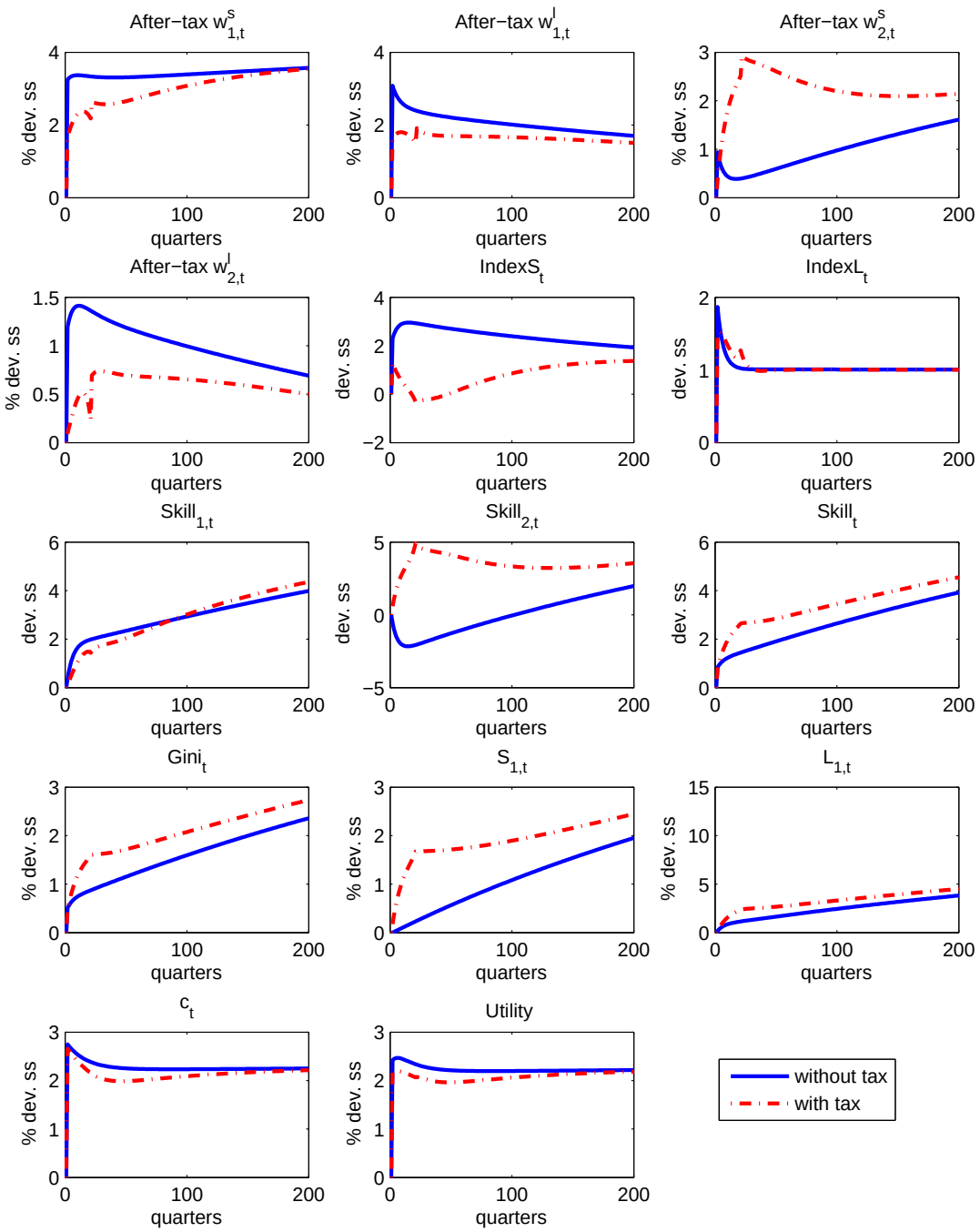

Figure 10:
Temporary migration subsidy to skilled labor financed by wage tax
Subsidy rises by 50 percentage points for 20 periods

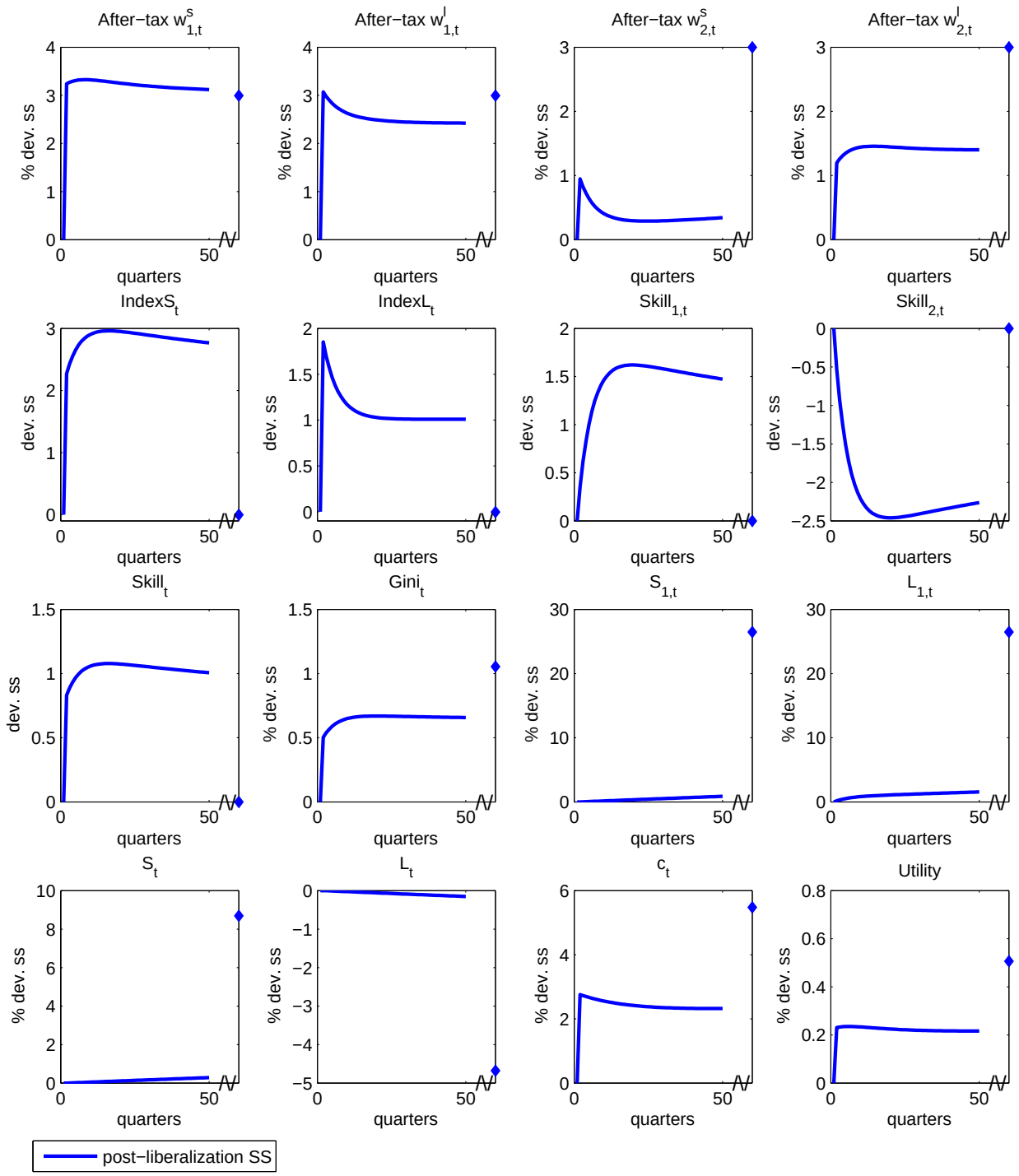

Figure 11:
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Iceberg trade costs fall from 1.3 to 1.2

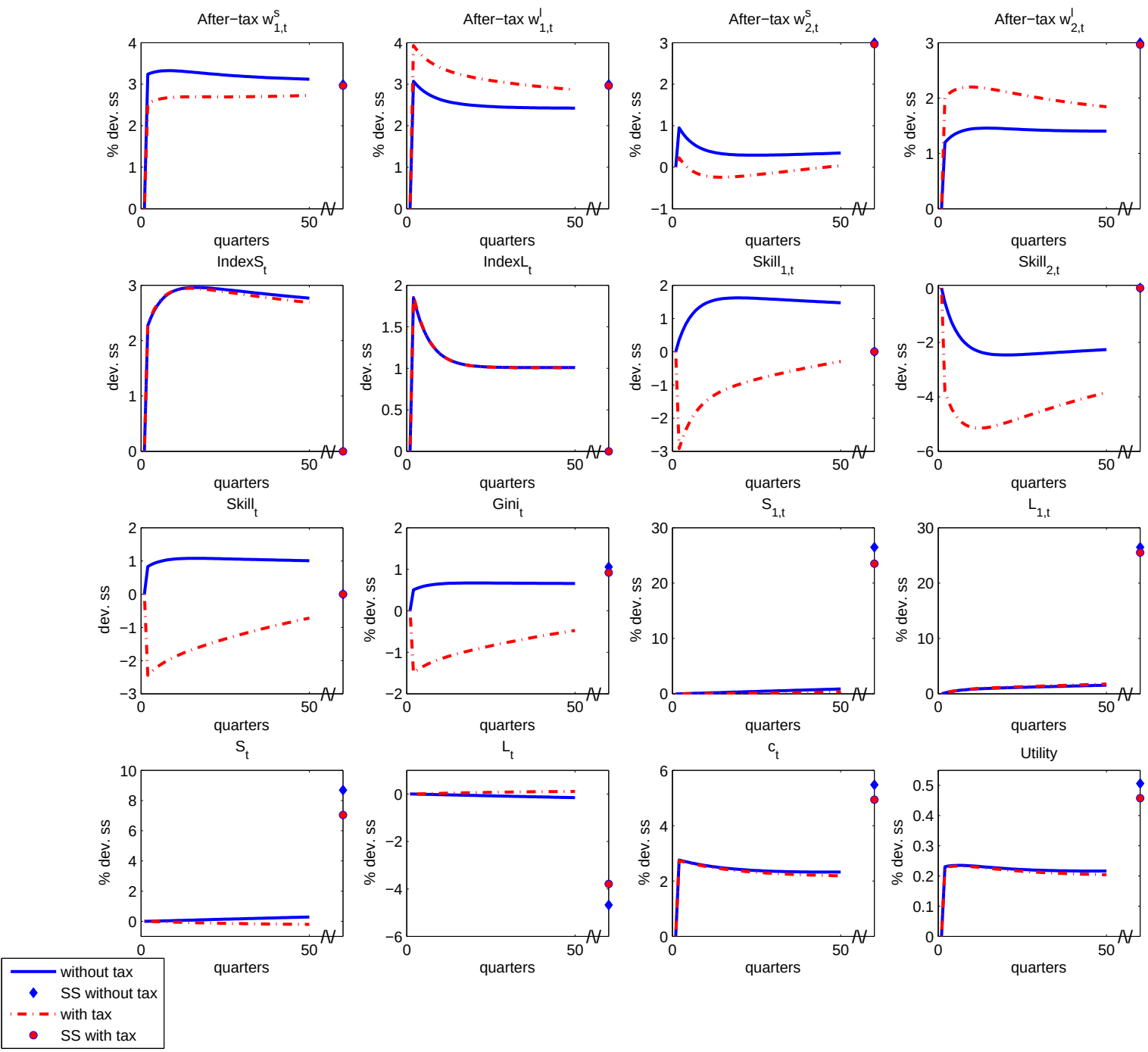

Figure 12:
Permanent wage tax on skilled labor financing wage subsidy on unskilled labor
Tax on skilled rises by 0.7 percentage points.

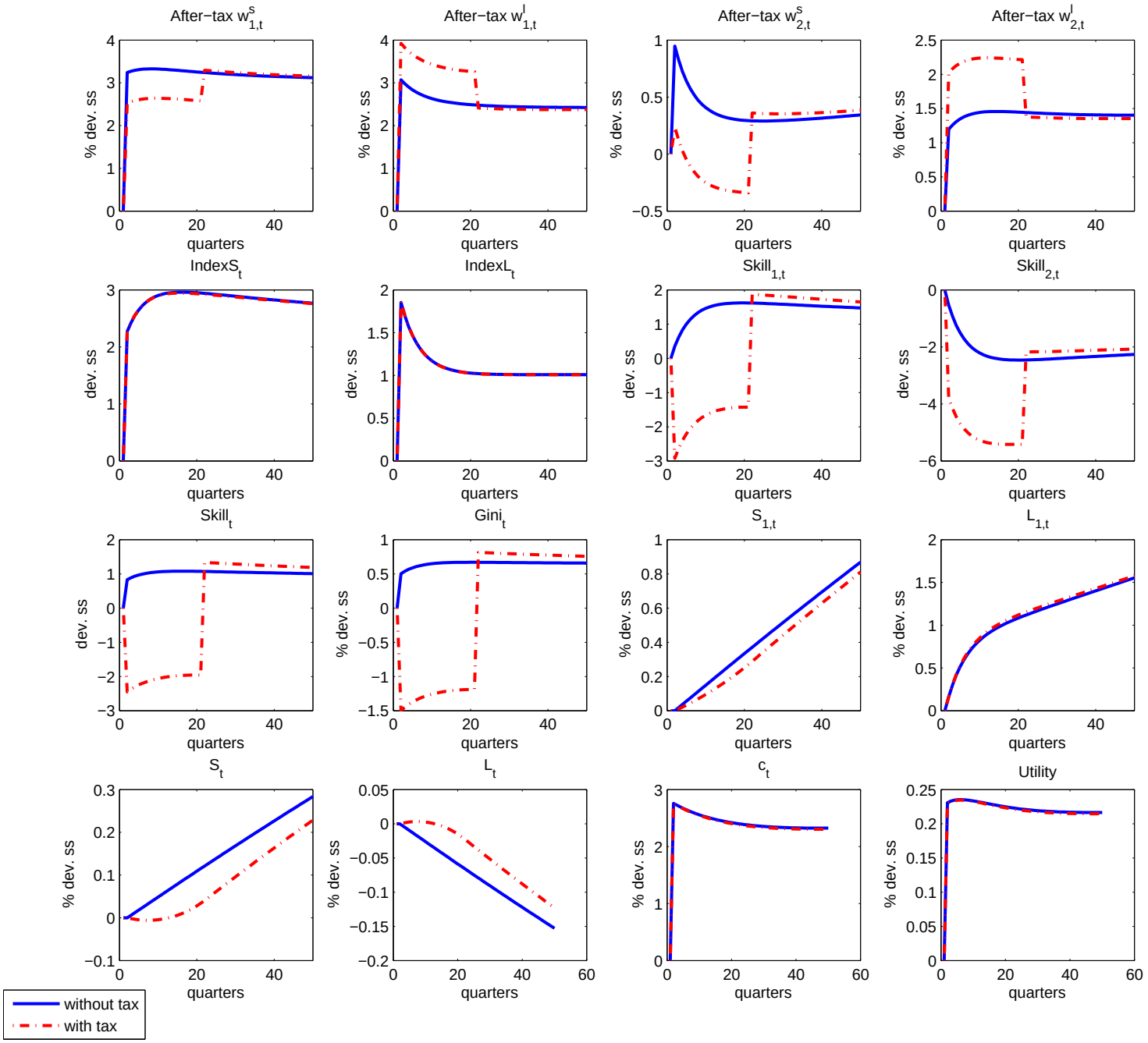

Figure 13:
Temporary wage tax on skilled labor financing wage subsidy on unskilled labor
Tax on skilled rises by 0.7 percentage points for 20 periods

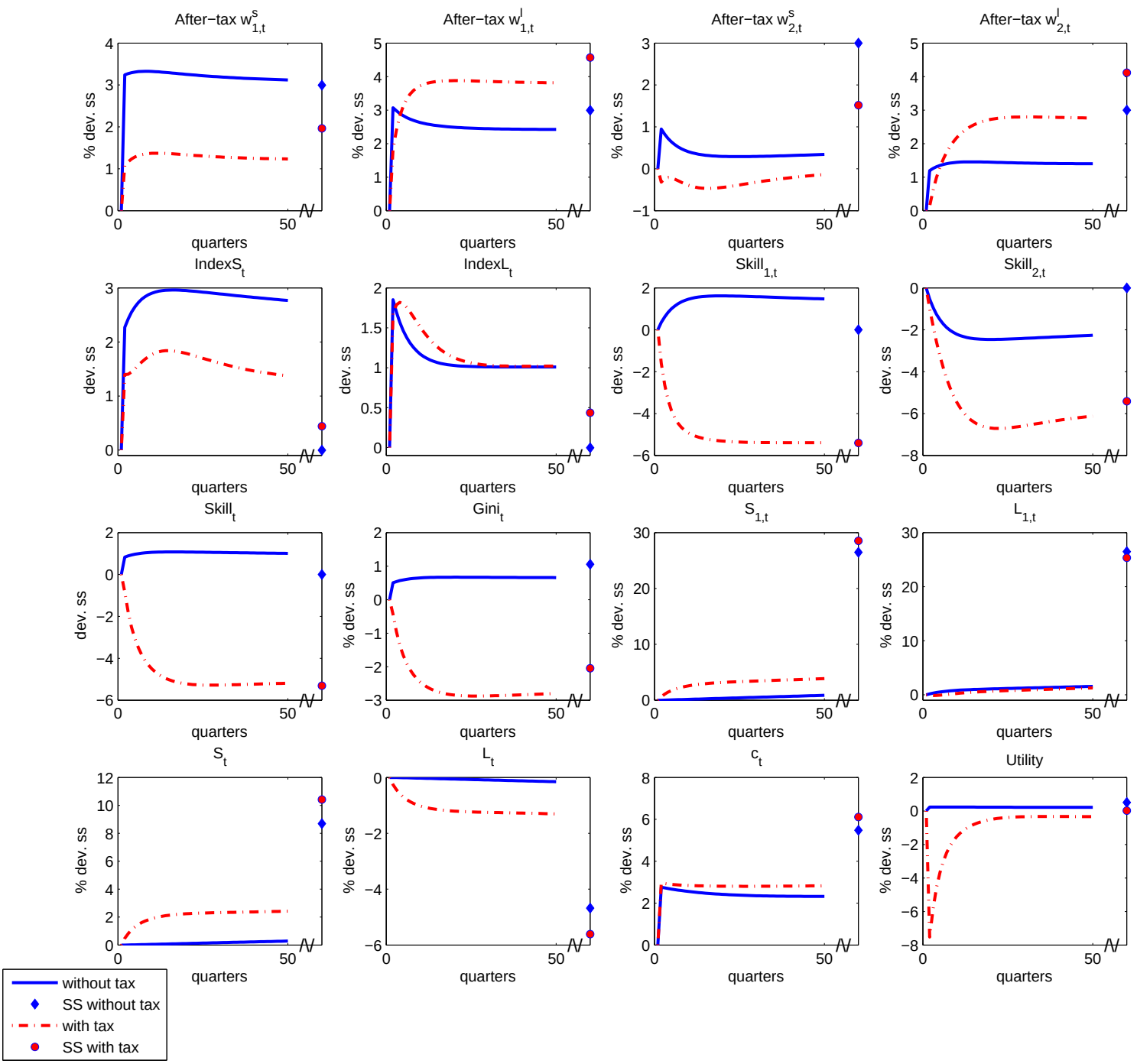

Figure 14:
Training subsidy financed by a wage tax
Subsidy rises permanently by 35 percentage points.

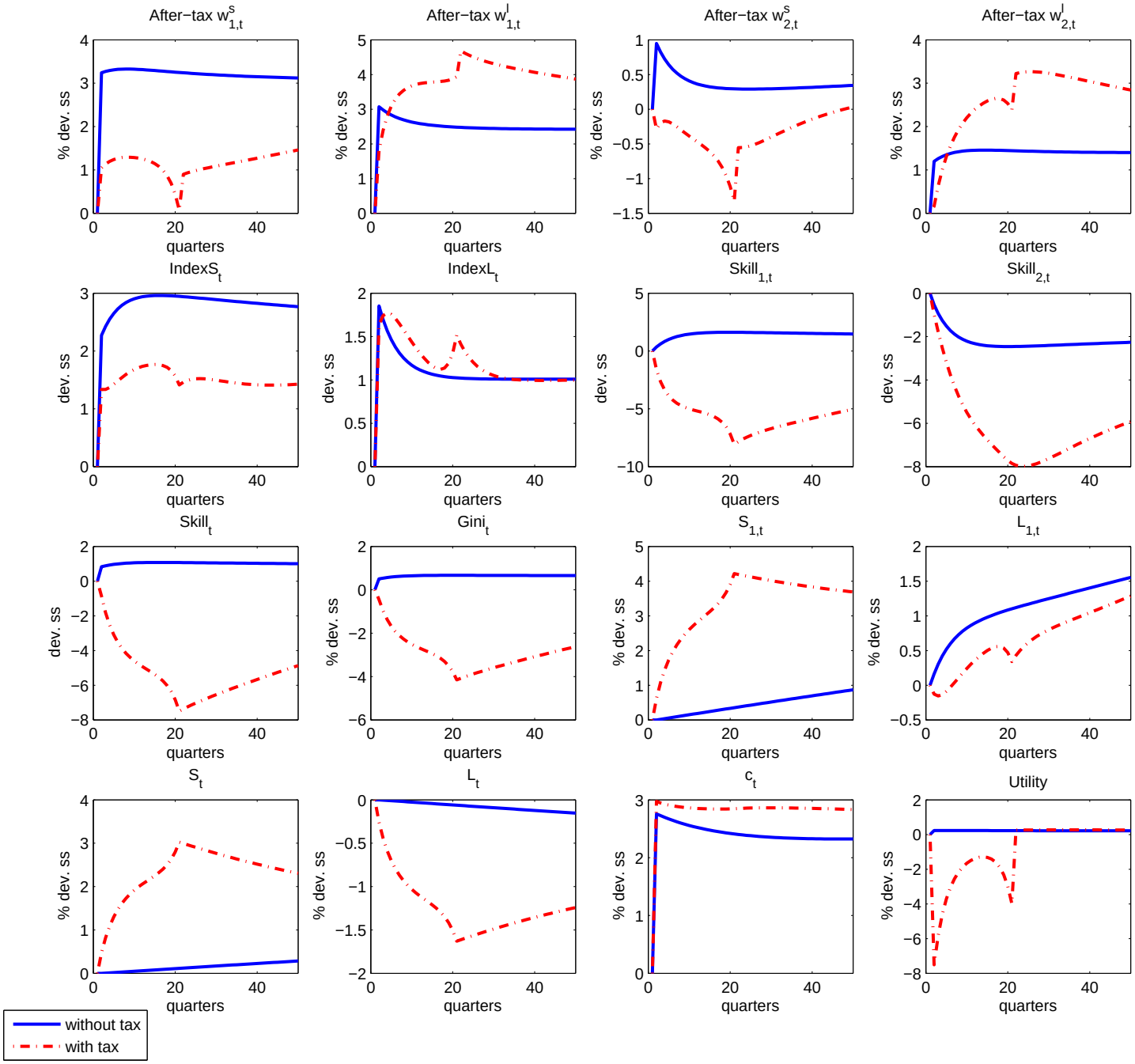

Figure 15:
Training subsidy financed by a wage tax
Subsidy rises by 35 percentage points for 20 periods

Appendix

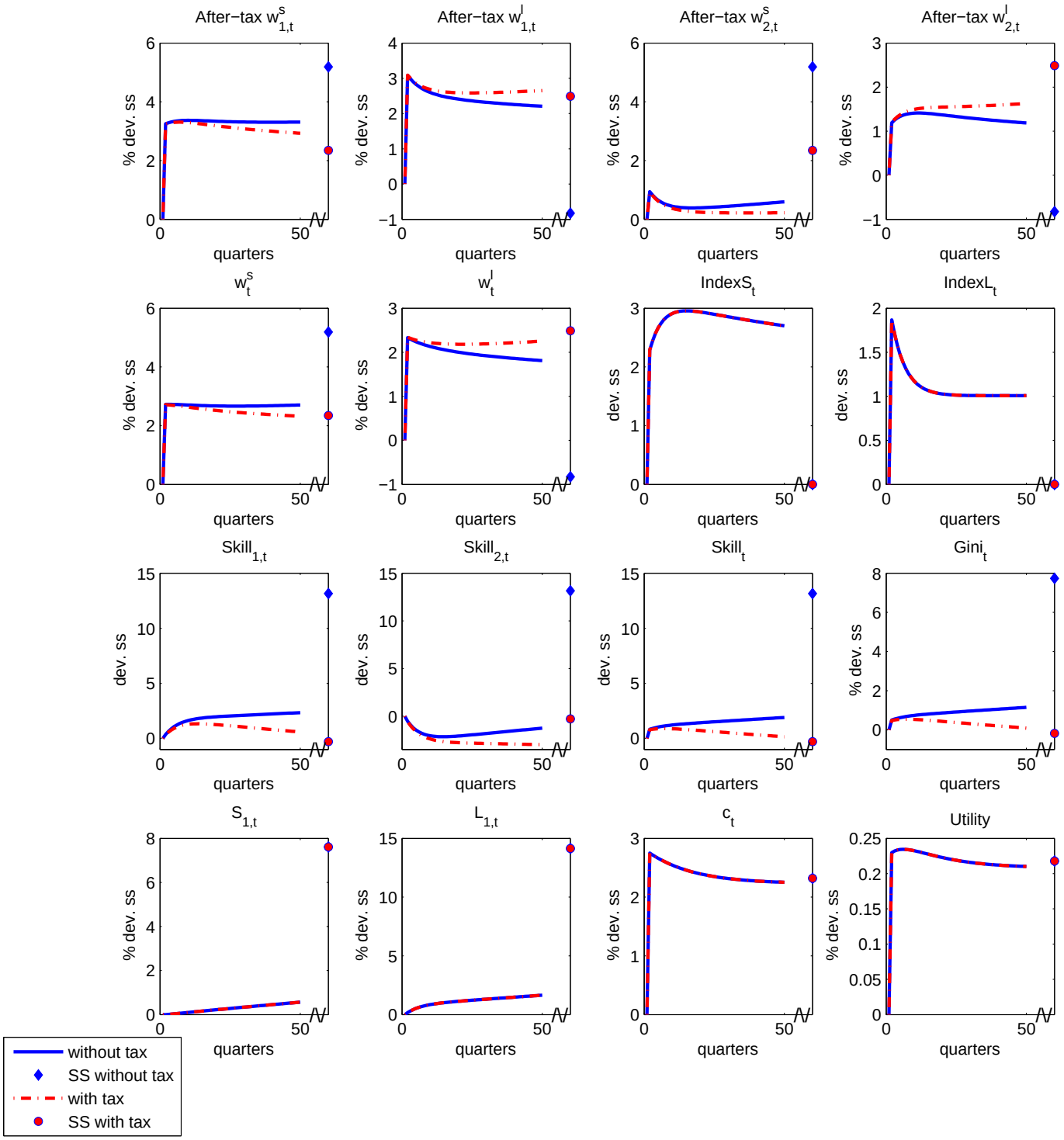

Figure 16:
Permanent wage tax on skilled labor financing wage subsidy on unskilled labor
Exogenous tax in period t : $tax_t = -0.997^t tax_0 + 0.027$with $tax_0 = 0.027$

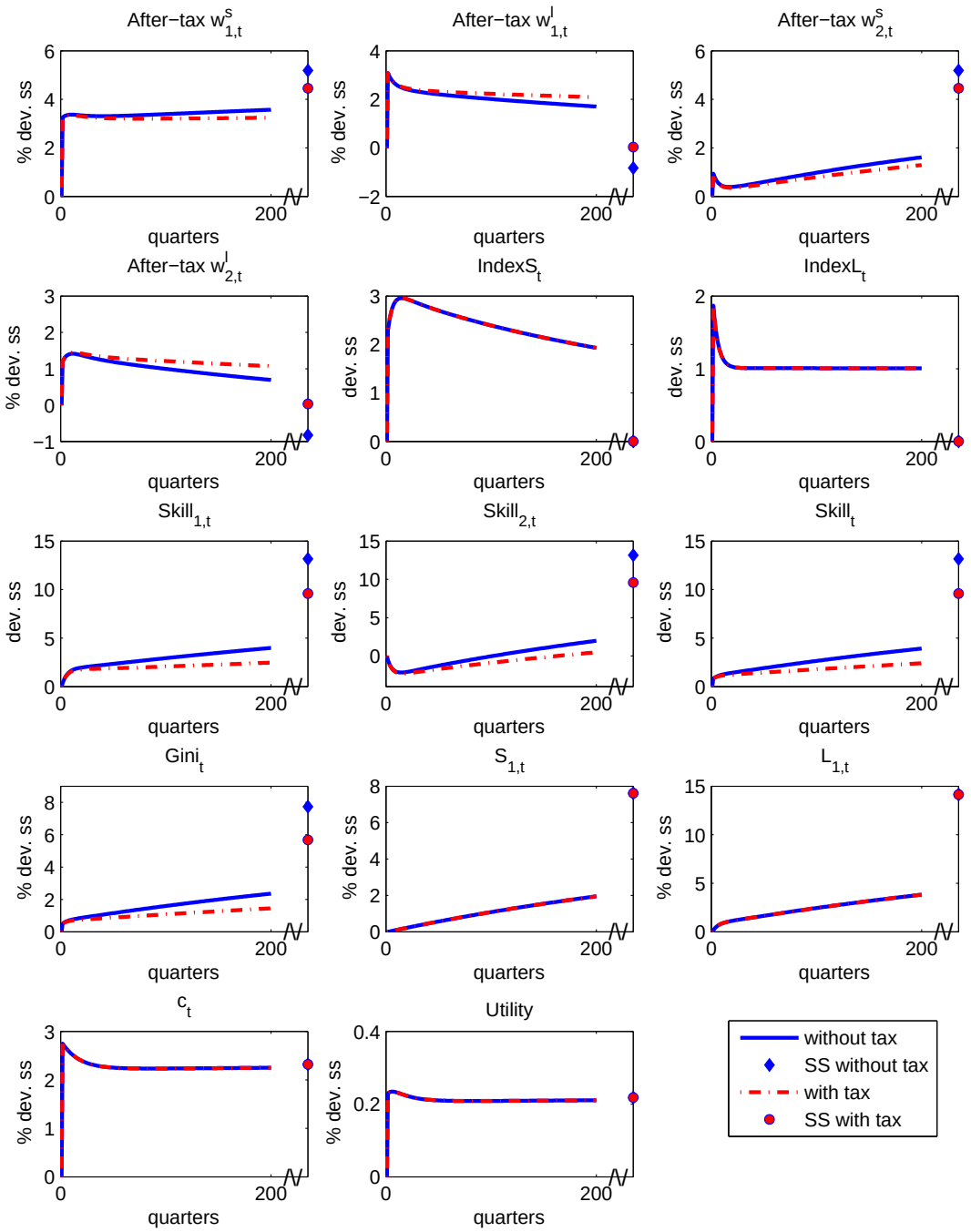

Figure 17:
Permanent wage tax on skilled labor financing wage subsidy on unskilled labor
Exogenous tax in period t: $tax_t = -0.997^t tax_0 + 0.007$ with $tax_0 = 0.007$

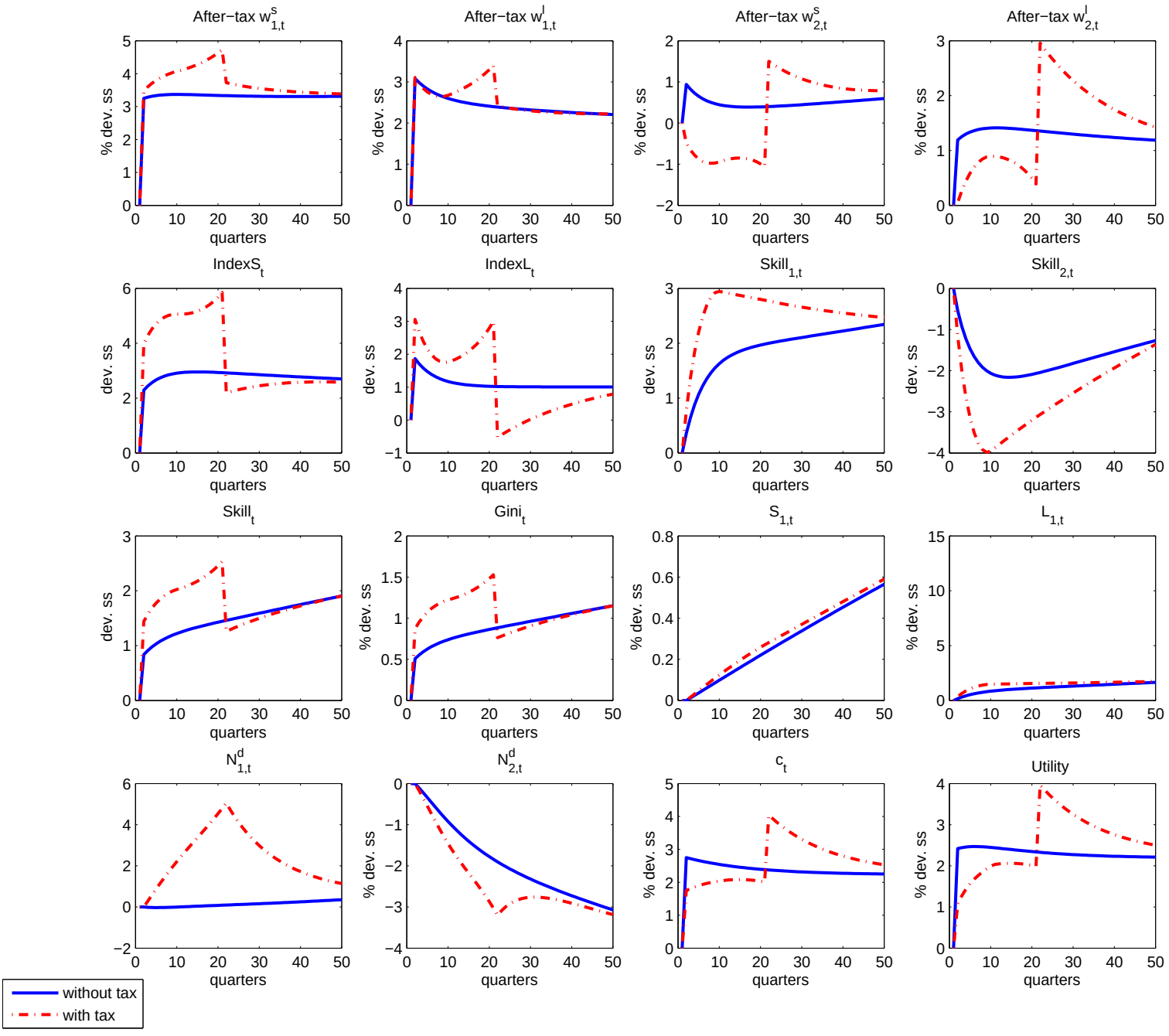

Figure 18:
Temporary firm entry subsidy in sector 1 financed by wage tax
Subsidy in sector 1 rises by 3.5 percentage points for 20 periods

Project Information

Welfare, Wealth and Work for Europe

A European research consortium is working on the analytical foundations for a socio-ecological transition

Abstract

Europe needs change. The financial crisis has exposed long-neglected deficiencies in the present growth path, most visibly in the areas of unemployment and public debt. At the same time, Europe has to cope with new challenges, ranging from globalisation and demographic shifts to new technologies and ecological challenges. Under the title of Welfare, Wealth and Work for Europe – WWWforEurope – a European research consortium is laying the analytical foundation for a new development strategy that will enable a socio-ecological transition to high levels of employment, social inclusion, gender equity and environmental sustainability. The four-year research project within the 7th Framework Programme funded by the European Commission was launched in April 2012. The consortium brings together researchers from 34 scientific institutions in 12 European countries and is coordinated by the Austrian Institute of Economic Research (WIFO). The project coordinator is Karl Aiginger, director of WIFO.

For details on WWWforEurope see: www.foreurope.eu

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