Working title: Comparative advantage and business cycle dynamics

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Abstract

Motivated by the increased importance of trade between industrialized and less-developed countries, we build a DSGE model featuring comparative advantage and inter-industry trade to analyze business cycle dynamics. We show that a negative productivity shock in the industrialized country temporarily strengthens its specialization in the exporting sector, increases the skill premium and overall wage inequality. Foreign shocks have sizable spillovers.

Keywords: international business cycles; inter-industry trade; trade liberalization; wage inequality; adjustment dynamics; redistribution;

JEL Classification: E20, E25, F41, F44, F62

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1 Introduction

Figure 1 shows the most important trading partners of the US and their shares in total trade with the US. The graph highlights two developments: The declining importance of trade with Canada and Japan and the increasing importance of trade with China and, to a lesser degree, Mexico. These trends mark a shift in the pattern of international trade since trade among industrialized countries is primarily driven by intra-industry trade, while trade between industrialized and less-developed countries is to a large degree inter-industry trade. The potential consequences of this shift for business cycle dynamics are still under-explored, mainly due to the restriction of existing business cycle models to intra-industry trade. We want to close this gap by developing a modern dynamic stochastic general equilibrium (DSGE) model that is based on comparative advantage and inter-industry trade.

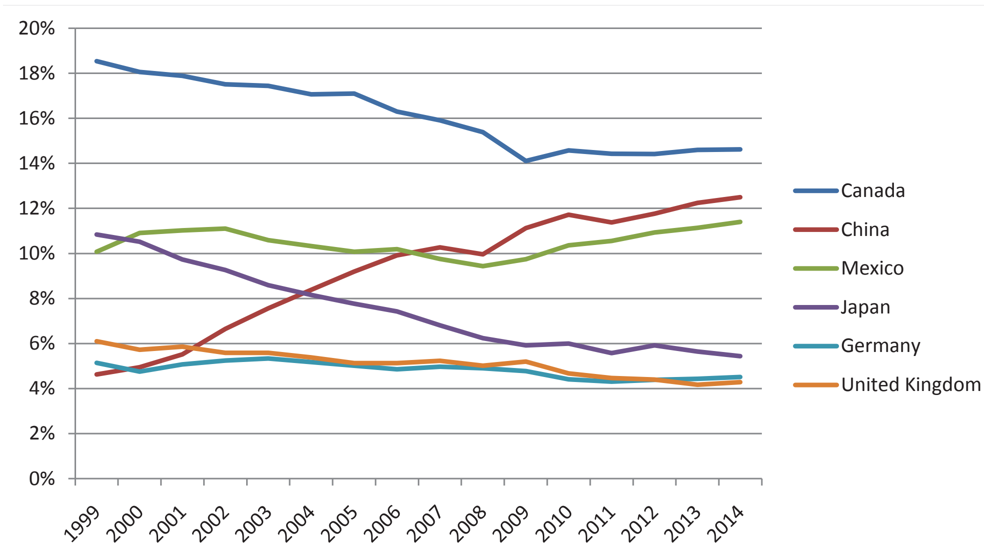

Figure 1: Trade shares of US trading partners

Motivated by the rising importance of trade between industrialized and developing countries, we want to analyze the consequences of comparative advantage for business cycle dynamics. Questions we are interested in are the following: Do business cycle shocks affect sectors differently even when the shocks are not sector-specific? If yes, what are the consequences for wage inequality? Do foreign productivity shocks affect the home economy differently if trade with the foreign country is based on inter-industry trade rather than intra-industry trade? How do the effects of monetary and fiscal policy shocks change in a model of comparative advantage?

To analyze these questions we use a dynamic version of the model developed in Bernard et al. [2007] (BRS henceforth). BRS combine heterogeneous firms and endogenous firm entry a la Melitz [2003] with comparative advantage. Thus they build a model that includes both inter- and intra-industry trade, but as most models in the trade literature their model is purely static. Numerous empirical studies have found firm heterogeneity, endogenous firm entry and selection into export markets to be important ingredients to explain patterns of international trade. Ghironi and Melitz

[2005] (GM henceforth) and Ghironi and Melitz [2007] have demonstrated their importance for international business cycles.

The model we use is a dynamic version of BRS, along the lines of GM, and is based on Lechthaler and Mileva [2013] (LM) and Lechthaler and Mileva [2014], who study the effects of trade liberalization on wage inequality. It is a model with two countries, two sectors and two factors of production, skilled and unskilled workers. The industrialized country has a relatively larger endowment with skilled workers and thus a comparative advantage in the skill-intensive sector. Trade liberalization induces both countries to specialize more (but not completely) in the production of their comparative advantage sector. We take the model in LM and extend it along various dimensions. We include nominal price rigidities along the lines of Cacciatore and Ghironi [2014], endogenous labor supply and government spending.

We find that in response to temporary, negative, non-sector-specific productivity shocks in the industrialized country, the industrialized country specializes more in its comparative advantage sector. In response to a negative productivity shock both sectors contract, but the comparative-disadvantage sector contracts by more and so the economy temporarily specializes more in its comparative advantage sector. The reason is that the reduced supply of exports and the reduced demand for imports lead to an appreciation in the real exchange rate. This raises the price of the comparative-advantage sector relative to the comparative-disadvantage sector, and thus production concentrates more in the comparative-advantage sector.

This increased specialization in the comparative-advantage sector raises the demand for skilled workers relative to unskilled workers, and as a result a larger share of total wage payments goes to the skilled workers. At the same time wages in the comparative-advantage sector increase relative to the comparative-disadvantage sector. Both effects tend to raise total income inequality as measured by the Gini coefficient, although the effects are not large.

Looking at aggregate indicators, the different developments in both sectors seem to largely wash out. Compared to a corresponding one-sector economy, aggregate output and inflation do not show significant differences. However, aggregate trade flows and the real exchange rate are less volatile in the two-sector economy.

Our model economy features sizable spillovers. In response to a temporary, negative, non-sector-specific productivity shock in the developing country aggregate output in the industrialized country contracts by almost half as much as in response to domestic shocks. The real exchange rate depreciates which leads to a temporary reduction in specialization in the industrialized country. The share of wage payments that goes to skilled workers goes down, while wage inequality across sectors goes up. The effects counteract each other, resulting in a tiny increase in overall wage inequality.

2 Theoretical model

We build a DSGE model which 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. There are two margins of labor input required, an extensive margin, the number of workers, and an intensive margin, hours worked. We use both margins to be able to capture comparative advantage, based on the number of workers in each sector which is constant over the business cycle, while at the same time allowing for some flexibility over the business cycle (adjustable hours worked).

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. H has a comparative advantage in producing good 1 because it has a higher relative endowment with skilled workers. Similarly, F has a comparative advantage in sector 2 because it has a higher relative endowment with unskilled workers. We assume that at the steady state unskilled workers are more abundant than skilled workers in both countries in order to generate a positive skill-premium.[1] In the long run, all factors of production are assumed to be perfectly mobile between sectors but not across countries. In the short run, i.e., at business cycle frequency, workers are immobile both across sectors and across skill-classes. At any frequency workers can choose how many hours to work which allows labor supply to adjust endogenously over the business cycle and gives rise to wage differentials across sectors and skill classes.

The model features a two tier production structure, which allows for the separation of nominal rigidities and endogenous investment in plants (and potentially plant heterogeneity). At the first stage multi-product firms invest in plants to produce a continuum of varieties. The number of varieties is endogenous because setting up a plant requires a sunk cost and every period an exogenous fraction of plants are destroyed. As in Cacciatore and Ghironi [2014], we introduce nominal frictions by assuming Rotemberg [1982] adjustment costs, i.e., firms have to pay a quadratic adjustment cost when changing the price of their products. At the second stage, the bundle of products produced by each firm is transformed into a CES aggregate sector good which is consumed by households with Cobb Douglas preferences in both sector goods. The presence of nominal frictions gives rise to inflation. Monetary policy is implemented through a standard Taylor rule which responds to inflation. The economy is subject to country-specific shocks aggregate productivity shocks. In the following section we describe all the decision problems in H; equivalent equations hold for F.

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

2.1 Households

In our model there are four types of households, ones that comprise of skilled workers in sector 1, skilled workers in sector 2 and the same for unskilled workers. The utility of a skilled workers household in sector i is given by:

$$E_t \left\{ \sum_{k=0}^{\infty} \gamma^k \left[log\left(C^s_{it+k}\right) S_i - \frac{\left(H^s_{it+k}\right)^{1+\zeta}}{1+\zeta} S_i \right] \right\}, \tag{1}$$

where C^s_{it+k} is the worker consumption bundle, H^s_{it+k} the hours supplied by each worker, S_i the number of workers in the household, γ the subjective discount factor and ζ is the inverse of the Frisch elasticity of labor supply. A likewise equation holds for unskilled workers. Every period households face the following budget constraint written in terms of final consumption:

$$\begin{aligned} S_i C^s_{it} + A^s_{it} + Q_t Af^s_{it} + \frac{\eta}{2}(A^s_{it})^2 + Q_t \frac{\eta}{2}(A^s_{it})^2 &= w^s_{it} H^s_{it} S_i + \frac{A^s_{it-1}(1+i_{t-1})}{1+\pi_t} \\ &+ Q_t \frac{Af^s_{it-1}(1+i^*_{t-1})}{1+\pi^*_t} + S_i \Pi_t. + TA^S_{it}. \end{aligned} \tag{2}$$

The left-hand side includes household expenditure on consumption $S_i C^s_{it}$, real H bonds A^s_{it} and real F bonds Af^s_{it}. F bonds are in terms of F consumption and are thus adjusted for the real exchange rate $Q_t \equiv e_t P^*_t / P_t$, defined as the relative price of F goods versus H goods and e_t, the nominal exchange rate which describes how many units of H currency are needed to buy one unit of F currency. Note that when purchasing bonds households have to pay a quadratic adjustment cost for H bonds $\frac{\eta}{2}(A^s_{it})^2$ and F bonds $Q_t \frac{\eta}{2}(A^s_{it})^2$. These costs are paid to financial intermediaries whose only function is to collect these transaction fees and rebate the revenue to households in a lump-sum fashion where the rebate is $TA^S_{it} = \frac{\eta}{2}(A^s_{it})^2 + Q_t \frac{\eta}{2}(A^s_{it})^2$. These bond adjustment costs are a standard way of ensuring that the model is stationary and the trade is always balanced in steady state. The right hand side includes all sources of income, the wage income $w^s_{it} H^s_{it} S_i$, the interest income on H bond holdings $\frac{A^s_{it-1}(1+i_{t-1})}{1+\pi_t}$ and F bond holdings $Q_t \frac{Af^s_{it-1}(1+i^*_{t-1})}{1+\pi^*_t}$, the profit transfers from owning firms Π_t (to be defined in more detail below) and the the bond cost rebate TA^S_{it}. i_{t-1} and i^*_{t-1} are the nominal interest rates on H and F bond holdings converted into real terms by adjusting for inflation at H π_t and at F π^*_t.

The household chooses consumption, hours worked and bond holdings to maximize utility subject to the budget constraint. The optimization problem implies the following optimality conditions:

$$\frac{(H^s_{it})^{\zeta}}{(C^s_{it})^{-1}} = w^s_{it}, \tag{3}$$

$$(1+\eta A_{it}^{s}) = \gamma E_t\left[(\frac{C_{t+1}}{C_t})^{-1}\frac{(1+i_t)}{(1+\pi_{t+1})}\right], \tag{4}$$

$$(1+\eta Af_{it}^{s}) = \gamma E_t\left[(\frac{C_{t+1}}{C_t})^{-1}\frac{(1+i_t^*)}{(1+\pi_{t+1}^*)}\frac{Q_{t+1}}{Q_t}\right]. \tag{5}$$

The first condition determines optimal labor supply by equating the marginal rate of substitution between leisure and consumption to the real wage. The other two conditions are the Euler equations that determine the optimal holdings of H and F bonds, respectively.

The composition of the aggregate consumption bundle is the same for all workers, only the quantity of consumed goods differs across workers. Therefore, in the following we will omit the indices for the workers to avoid cumbersome notation. The aggregate consumption bundle C_t is a Cobb-Douglas composite of the goods produced in the two sectors:

$$C_t = C_{1t}^{\alpha}C_{2t}^{1-\alpha}, \tag{6}$$

where α is the share of good 1 in the consumption bundle for both H and F. We can obtain relative demand functions for each good from the expenditure minimization problem of a household. The implied demand functions are:

$$C_{1t} = \alpha\frac{P_t}{P_{1t}}C_t \;\; and \;\; C_{2t} = (1-\alpha)\frac{P_t}{P_{2t}}C_t, \tag{7}$$

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 bundle C_t.

Goods 1 and 2 are consumption bundles that aggregate over domestic and imported goods in a Dixit-Stiglitz form:

$$C_{it} = \left[\int_0^1 c_{it}(k)^{\frac{\phi-1}{\phi}}dk\right]^{\frac{\phi}{\phi-1}}, \tag{8}$$

where $\phi > 1$ is the elasticity of substitution between goods. The consumption based price index for each sector is $P_{it} = \left[\int_0^1 p_{it}(k)^{1-\phi}dk\right]^{\frac{1}{1-\phi}}$ and the household demand for each good is $c_{it} = \left(\frac{p_{it}}{P_{it}}\right)^{-\phi}C_{it}$. It is useful to redefine these in terms of aggregate consumption units. 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 bundles, respectively. Then, we can rewrite the demand functions for goods and sector bundles as $c_{it} = \rho_{it}^{-\phi}C_{it}$ and $C_{it} = \alpha\psi_{it}^{-1}C_t$, respectively.

2.2 Production

There are two sectors of production in each country. Within each sector: there are a continuum of firms that produce a variety of products in different plants.

Each monopolistically competitive firm j produces output bundle $Y_t(j)$, sold to consumers in H and F. Producer j is a multi-product firm that produces a set of differentiated product varieties, indexed by ω and defined over a continuum :

$$Y_{it}(j) = \left[\int_{\omega \in \Omega}^{\infty} y_{it}(\omega, j)^{\frac{\theta-1}{\theta}} d\omega \right]^{\frac{\theta}{\theta-1}}, \tag{9}$$

where $\theta > 1$ is the symmetric elasticity of substitution across product varieties.

Each product variety $y_{it}(\omega, j)$ is created and developed by the representative final producer j. Since all firms are symmetric in the economy, henceforth, we simplify notation by omitting the index j. The cost of the product bundle Y_{it}, denoted with P_{it}^{y} , is $P_{it}^{y} = \left[\int_{\omega \in \Omega}^{\infty} p_{it}^{y}(\omega)^{1-\theta} d\omega \right]^{\frac{1}{1-\theta}}$, where $p_{it}^{y}(\omega)$ is the nominal marginal cost of producing variety ω.

The number of products created and commercialized by each firm is endogenous. At each point in time, only a subset of varieties $\Omega_t \in \Omega$ is actually available to consumers. To create a new product, the firm needs to undertake a sunk investment, f_e, in effective labor units. Product creation requires each firm to create a new plant that will be producing the new variety. The representative monopolistically competitive multi-product firm uses skilled and unskilled labor to set up plants and produce its products. To avoid cumbersome notation, we also omit the index ω pertaining to individual plants. The production technology is the same for all plants and is assumed to be Cobb-Douglas in the two inputs of production:

$$y_{it} = Z_t \left(S_i H_{it}^{S} \right)^{\beta_i} \left(L_i H_{it}^{L} \right)^{(1-\beta_i)} \tag{10}$$

where S_i and L_i are the amounts of skilled and unskilled workers used in a plant, H_{it}^{S} and H_{it}^{L} are the skilled and unskilled hours for which the workers are hired. Note that the number of workers is exogenous for each sector while the hours are endogenous. Z_t is time-varying productivity which follows an AR(1) process with a parameter ρ_z and each period is subject to i.i.d. shocks $\varepsilon_z$with Normal distribution of mean 0 and standard deviation σ_z. β_i is the share of skilled labor required by a plant to produce one unit of output y_{it} 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 hourly real wages of both skilled and unskilled workers equal the values of their marginal products of labor. Note that for each plant the firm chooses hours for all of its workers $(S_i H_{it}^{S})$ rather than hours for individual workers H_{it}^{S}. In addition, workers are perfectly mobile across plants which implies that all plants pay the same wage. Consequently, relative labor demand can be described by the following condition:

$$\frac{w_{it}^{S}}{w_{it}^{L}} = \frac{\beta_i}{(1-\beta_i)} \frac{L_i H_{it}^{L}}{S_i H_{it}^{S}}, \tag{11}$$

which says that the ratio of the skilled hourly real wage w_{it}^{s} to the unskilled hourly real wage w_{it}^{L}

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 implies that relative demand for labor is the same across plants. Perfect competition implies that this condition is identical for all firms within a sector. This condition is valid for both sectors.

The real marginal cost faced by each plant is $\frac{p^y_{it}(\omega)}{P_t} = \left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}/Z_t$. The entry cost paid to set up a plant is $f_{et}\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}$. Note that entry costs can differ between sectors due to different factor intensities and due to inter-sectoral wage differentials.

At time t, each firm commercializes M_{it} products and creates $M_{e,it}$ new products that will be available for sale at time t + 1. New and incumbent plants can be hit by an identical shock with probability $\delta \in (0,1)$ at the end of each period. The law of motion for the stock of producing plants is:

$$M_{it} = (1-\delta)(M_{it-1} + M_{e,t-1}). \tag{12}$$

Exporting goods to F is costly and involves an iceberg trade cost $\tau_t \geq 1$.[2] Each firm sells all of its product varieties to both H and F.

The amount of products that each representative firm creates is determined endogenously where the firm minimizes its cost function subject to equation 12 and the definition of the real marginal cost of producing the bundle of varieties Y_t . Note that all plants face an identical real marginal cost when producing a variety $\frac{p^y_{it}(\omega)}{P_t} = \left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}/Z_t$, which implies that the real marginal cost of the bundle is $\frac{P^y_{it}}{P_s} = \frac{\left[\int_{\omega\in\Omega}^{\infty} p^y_{it}(\omega)^{1-\theta}d\omega\right]^{\frac{1}{1-\theta}}}{P_t} = \frac{\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}}{Z_t}\frac{\left[\int_{\omega\in\Omega}^{\infty} 1 d\omega\right]^{\frac{1}{1-\theta}}}{P_t} = M_{it}^{\frac{1}{1-\theta}}\frac{\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}}{Z_t}$.

The firms seeks to minimize total cost of production which is $E_t\sum_{s=t} D_s[M_s^{\frac{1}{1-\theta}}\frac{\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}}{Z_s}Y_{d,s} + \tau M_s^{\frac{1}{1-\theta}}\frac{\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}}{Z_s}Y_{x,s} + \left(\frac{M_{s+1}}{1-\delta} - M_s\right) f_e\frac{\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}}{Z_s}]$, where $D_{t,t+1}$is the discount factor faced by the firm, $Y_{d,t}$ and $Y_{x,t}$ are the output bundles sold domestically and abroad. Note that the discount factor faced by the firm is assumed to equal the household stochastic discount factor such that $D_{t,t+1} = (1+\pi_{t+1})/(1+i_t)$. The optimal condition implies that, in equilibrium, the cost of producing an additional variety $f_e\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}/Z_t$, must be equal to its expected benefit, which includes the marginal revenue from commercializing the variety plus the expected savings on future sunk investment costs, such that

$$\begin{aligned} f_e\frac{\left(w^s_{it}\right)^{\beta_i}\left(w^l_{it}\right)^{1-\beta_i}}{Z_t} &= (1-\delta)\,D_{t,t+1}[\frac{1}{\theta-1}\left(\frac{P^y_{it+1}}{P_{t+1}}\frac{Y_{d,it+1}}{M_{t+1}} + \tau\frac{P^y_{it+1}}{P_{t+1}}\frac{Y_{x,it+1}}{M_{t+1}}\right) \\ &\quad + f_e\frac{\left(w^S_{it+1}\right)^{\beta_i}\left(w^L_{it+1}\right)^{1-\beta_i}}{Z_{t+1}}]. \end{aligned} \tag{13}$$

[2]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 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.

The demand curves that each firm faces for its bundles at H and at F are $Y_{d,it} = \left(\frac{p_{dt}}{P_{it}}\right)^{-\phi} C_{it}$ $Y_{x,it} = \left(\frac{p_{xt}}{P^*_{it}}\right)^{-\phi} C^*_{it}$ where $p_{d,it}$ and $p_{x,it}$ denote domestic and export prices, C_{it} and C^*_{it} are the aggregate demands for the sector consumption baskets at H and F. Note that the firm exports the same bundle that it sells domestically. We also assume producer currency pricing : each firm sets the export price in domestic currency. Therefore, the firm sets only the domestic price $p_{d,it}$ and the export price is determined by the law of one price such that $p_{x,it} = \tau p_{d,it}/e_t$, where e_t is the nominal exchange rate. The prices of the bundles are sticky. We follow Rotemberg [1982] and assume that firms must pay quadratic price adjustment costs when changing prices. Let $\pi_{d,it} = (p_{d,it}/p_{d,it-1} - 1)$ and $\pi^h_{x,it} = (p^h_{d,it}/p^h_{x,it-1} - 1)$ be the domestic and export inflation rates in a sector. The nominal cost of adjusting prices is $\upsilon\pi^2_{d,it}p_{d,it}Y_{d,it}/2$, where$\upsilon \geq 0$ determines the size of the adjustment costs. Optimal price setting implies that firms set the price $\rho_{d,it} = p_{d,it}/P_t$(defined in terms of units of final consumption) at time-varying markup over its real marginal cost so that

$$\frac{p_{d,t}}{P_t} = \mu_{d,it}\frac{\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}}{Z_t}. \tag{14}$$

Price stickiness introduces endogenous markup variations where $\mu_{d,it} = \phi/[(\phi-1)(1-\frac{\upsilon}{2}\pi^2_{di,t}) + \upsilon\pi_{di,t}(\pi_{di,t}+1) - \upsilon E_t D_{t,t+1}\pi_{di,t+1}(\pi_{di,t+1}+1)^2\frac{1}{\pi^C_{t+1}+1}\frac{Y_{di,t+1}}{Y_{di,t}}]$. The cost of adjusting prices gives firms an incentive to change their markups over time in order to smooth price changes across periods. If prices are flexible and $\upsilon = 0$, the markup is constant and equal to $\phi/(\phi-1)$. Note that by substitution the export price, defined in foreign consumption units, is $\rho_{x,it} = \frac{p_{x,t}}{P^*_t} = \frac{\tau}{Q_t}\rho_{d,it}$.

The price index in each sector is weighted average of domestic and import prices such that:

$$\psi^{1-\phi}_{it} = M_{it}^{\frac{1-\phi}{1-\theta}}\rho^{1-\phi}_{d,it} + M_{it}^{*\frac{1-\phi}{1-\theta}}\rho^{*1-\phi}_{x,it} = M_{it}^{\frac{1-\phi}{1-\theta}}\rho^{1-\phi}_{d,it} + M_{it}^{*\frac{1-\phi}{1-\theta}}\left(\tau^*\rho^*_{d,it}Q_t\right)^{1-\phi}. \tag{15}$$

Finally it is also useful to express the average output of domestic and exported varieties: $y_{d,it} = M^{\frac{\theta-\phi}{1-\theta}}\rho^{-\phi}_{d,it}C_{it}/\psi^{-\phi}_{it}$ and $y_{x,it} = M^{\frac{\theta-\phi}{1-\theta}}\rho^{-\phi}_{x,it}C^*_{it}/\psi^{*-\phi}_{it}$

2.3 Market Clearing Conditions, Aggregate Accounting and Trade

Market clearing requires that total production in each sector must equal total income so that:

$$M_{it}\rho_{d,it}y_{d,it} + Q_tM_{it}\rho_{x,it}y_{x,it} = w^S_{it}S_iH^S_{it} + w^L_{it}L_iH^L_{it} + T_{it}. \tag{16}$$

Total production of the sector includes the production of the aggregate consumption bundle and the production of new firms. Total income generated by the sector includes wage earnings and profits.

T_{it} are profit transfers net of investment in new products that the firms in the sector relay to workers, where $T_{it} = (1-1/\mu_{d,it} - \upsilon\pi^2_{d,it}/2)(M_{it}\rho_{d,it}y_{d,it} + Q_tM_{it}\rho_{x,it}y_{x,it}) - f_{et}\left(w^S_{it}\right)^{\beta_i}\left(w^L_{it}\right)^{1-\beta_i}M_{e,it}$. We assume that the transfers of both sectors are distributed equally between households such that

$\Pi_t = \sum_{i=1}^{2}(T_{it})/\sum_{i=1}^{2}(S_i + L_i)$.

The trade balance is defined as:

$$tb_t = \sum_{i=1}^{2} Q_t M_{it}\rho_{x,it}y_{x,it} + M_{it}^{*}\rho_{x,it}^{*}y_{x,it}^{*}. \tag{17}$$

Let us define aggregate bond holdings in the H country as $A_t \equiv \sum_{i=1}^{2}(A_{it}^{S} + A_{it}^{L})$ and $Af_t \equiv \sum_{i=1}^{2}(Af_{it}^{S} + Af_{it}^{L})$ for H and F bonds, respectively. Similarly, aggregate bond holdings in the F country are $A_t^{*} \equiv \sum_{i=1}^{2}(A_{it}^{*S}+A_{it}^{*L})$ and $Af_t^{*} \equiv \sum_{i=1}^{2}(Af_{it}^{*S}+Af_{it}^{*L})$. In equilibrium, the international net supply of bonds is zero for both H bonds such that $A_t + A_t^{*} = 0$ and for F bonds such that $Af_t + Af_t^{*} = 0$. Then the net foreign assets evolve according to the following law of motion:

$$A_t + Q_t Af_t = \frac{1 + i_{t-1}}{1 + \pi_t}A_{t-1} + \frac{1 + i_{t-1}^{*}}{1 + \pi_t^{*}}Af_{t-1}Q_t + tb_t. \tag{18}$$

2.4 Monetary Policy

To close the model described above, we must specify the behavior of monetary policy. The policy is captured by a standard rule for interest rate setting in the spirit of Taylor [1993] for both central banks. With a flexible exchange rate regime, each country's central bank sets its policy instrument following an interest rule. Since we aim to capture the monetary policy behavior of developed countries operating in the post-Bretton Woods era, in addition to flexible exchange rate regime, we assume that the central bank of each country sets its interest rate to respond to CPI inflation[3] such that :

$$(1 + i_t) = (1 + i_{t-1})^{\kappa_i}\left[(1 + i)(1 + \pi_t)^{\kappa_\pi}\right]^{1-\kappa_i}, \tag{19}$$

where $\kappa_i \in [0, 1)$ is an interest rate smoothing parameter and$\kappa_\pi$is a parameter that characterizes the degree to which the interest rate responds to inflation. A similar rule holds for the F country.

2.5 Measures for wage inequality

In order to analyze the effect of the business cycle on various sources of inequality, we define a number of wage inequality measures. First, we define two measures of wage inequality across sectors. They measure the relative percentage difference across sectoral wages for skilled and

[3]Ghironi and Melitz [2005] point out that, in the presence of endogenous product creation and 'love for variety' in the production of final consumption-varieties, variables measured in units of consumption do not have a direct counterpart in the data, i.e., they are not data-consistent. As the economy experiences entry of Home and Foreign firms, the welfare-consistent aggregate price index P_t can vary even if product prices remain constant. In the data, however, aggregate price indexes do not take these variety effects into account. However, our set-up implies that the number of varieties are endogenously determined within a representative firm. The firm sets its price optimally taking account of the variety of products it offers. As a result, the price indices that consumers and the central bank observe take account of the fact that changing variety of products could also affect inflation. Thus, we do not adjust our inflation measure for 'love of variety'. In any case, using an adjusted inflation measure in the monetary policy rule does not have a noticable impact on our results.

unskilled workers

$$IndexS_t = \left(\frac{w_{1t}^S}{w_{2t}^S} - 1\right)100,$$
$$IndexL_t = \left(\frac{w_{1t}^L}{w_{2t}^L} - 1\right)100.$$

Note that these indices are close to zero at the steady state, due to 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 the 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

$$Skill_{it} = \left(\frac{w_{it}^S}{w_{it}^L} - 1\right)100.$$

For brevity, let $S = S_1 + S_2$ and $L = L_1 + L_2$. To define the average skill premium for each country, we use the average wage of skilled workers, $w_t^S = \frac{S_1}{S} w_{1t}^S + \frac{S_2}{S} w_{2t}^S$, and the average wage of unskilled workers, $w_t^L = \frac{L_1}{L} w_{1t}^L + \frac{L_2}{L} w_{2t}^L$ to obtain

$$Skill_t = \left(\frac{w_t^S}{w_t^L} - 1\right)100.$$

Note that the average wage in country H is $w_t = \frac{S_1}{S+L} w_{1t}^S + \frac{S_2}{S+L} w_{2t}^S + \frac{L_1}{S+L} w_{1t}^L + \frac{L_2}{S+L} w_{2t}^L$. Note also that the above measures of the skill premium are based on hourly wages. However, to capture what happens to income inequality we also define a wage differential across skilled and unskilled workers based on wage income:

$$Skill_{it}^I = \left(\frac{w_{it}^S H_{it}^S}{w_{it}^L H_{it}^L} - 1\right)100.$$

For the average wage differential for skilled and unskilled, we define the average wage income for skilled workers as $w_t^{IS} = \frac{S_1}{S} w_{1t}^S H_{1t}^S + \frac{S_2}{S} w_{2t}^S H_{2t}^S$, and for unskilled workers $w_t^{IL} = \frac{L_1}{L} w_{1t}^L H_{1t}^L + \frac{L_2}{L} w_{2t}^L H_{2t}^L$, to get:

$$Skill_t^I = \left(\frac{w_t^{IS}}{w_t^{IL}} - 1\right)100.$$

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 wage income 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 income distribution. The Gini coefficient for country H is

$$Gini_t^I = \frac{1}{2w_t^I}\frac{1}{(S+L)^2}(2S_1S_2\left|w_{1t}^S H_{1t}^S - w_{2t}^S H_{2t}^S\right| + 2L_1L_2\left|w_{1t}^L H_{1t}^L - w_{2t}^L H_{2t}^L\right|$$
$$+2S_1L_1\left|w_{1t}^S H_{1t}^S - w_{1t}^L H_{1t}^L\right| + 2S_2L_2\left|w_{2t}^S H_{2t}^S - w_{2t}^L H_{2t}^L\right|$$
$$+2S_1L_2\left|w_{1t}^S H_{1t}^S - w_{2t}^L H_{2t}^L\right| + 2S_2L_1\left|w_{2t}^S H_{2t}^S - w_{1t}^L H_{1t}^L\right|)$$

where $w_t^I = \frac{S_1}{S+L}w_{1t}^S H_{1t}^S + \frac{S_2}{S+L}w_{2t}^S H_{2t}^S + \frac{L_1}{S+L}w_{1t}^L H_{1t}^L + \frac{L_2}{S+L}w_{2t}^L H_{2t}^L$ is the average wage income.

Finally, we define a Gini index that captures welfare inequality, based on the period utility functions of workers defined as $u_{it}^S = log(C_{it}^S) - H_{it}^{S(1+\zeta)}/(1+\zeta)$ and $u_{it}^L = log(C_{it}^L) - H_{it}^{L(1+\zeta)}/(1+\zeta)$ for skilled and unskilled workers, respectively. The average utility per worker is $u_t = \frac{S_1}{S+L}u_{1t}^s + \frac{S_2}{S+L}u_{2t}^s + \frac{L_1}{S+L}u_{1t}^L + \frac{L_2}{S+L}u_{2t}^L$.We define the welfare Gini as:

$$Gini_t^W = \frac{1}{2u_t}\frac{1}{(S+L)^2}(2S_1S_2\left|u_{1t}^S - u_{2t}^S\right| + 2L_1L_2\left|u_{1t}^L - u_{2t}^L\right|$$
$$+2S_1L_1\left|u_{1t}^S - u_{1t}^L\right| + 2S_2L_2\left|u_{2t}^S - u_{2t}^L\right| + 2S_1L_2\left|u_{1t}^S - u_{2t}^L\right| + 2S_2L_1\left|u_{2t}^S - u_{1t}^L\right|).$$

3 Parametrization

This section describes the parametrization of the model that we use for the numerical simulations. In most aspects we follow GM and BRS. 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 inverse of the Frisch labor supply elasticity ζ equal to 1, again a standard choice for 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]. Similarly to Cacciatore and Ghironi [2014], we set the elasticity between variety bundles $\phi = \theta$. In order to avoid asymmetry due to demand effects, we set the share of each sector good in consumer expenditures equal to ($\alpha_1 = \alpha_2 = 0.5$). We also set the parameter for adjustment costs of international bond portfolios to $\eta = 0.0025$, in line with GM.

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 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 GM.

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 $S^* = 300$ and $L^* = 1700$ for F. These numbers imply that the share of skilled workers in the whole workforce is 35% for the rich country and 15% 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]).

Following Cacciatore and Ghironi [2014], we set the cost parameter for adjusting prices υ to 80. The interest rate smoothing parameter κ_i is 0.8 and the parameter that characterizes the response of the nominal interest rate to inflation κ_π is 1.5.

The persistence parameters for both productivity shocks are ρ_z are 0.95 and the standard deviation of the shocks are $\sigma_z = \sigma_{z*} = 0.01$.

Finally, for our benchmark scenario we assume that the iceberg trade costs for both countries are $\tau = \tau^* = 1.3$. For the autarky scenario we set the iceberg transport costs to $\tau = \tau^* = 10$. Detailed description of a one sector version of the model with intra-industry trade can be found in Cacciatore and Ghironi [2014]. We have simplified their model by assuming that there are no search and matching frictions in the labor market and that the extensive margin of labor supply is exogenous. We have also assumed that firms have homogenous productivity. The parametrization is identical to the two sector model except for the exogenous labor supply which is set so that the one sector model Home country GDP equals the Home country GDP in the two sector model.

4 Results

In this section we will discuss the reaction of our model economy in response to two standard shocks, a temporary productivity shock at Home and a temporary productivity shock at Foreign. In each case we will first discuss the effect of the shock on both sectors and then compare the aggregate effects to a model without trade and a model without comparative advantage.

Before starting the discussion of these shocks, let us briefly discuss the steady state in this economy. As pointed out in the parameterization section, we assume that Home is relatively abundant in skilled workers, which means that the share of skilled workers to unskilled workers is higher in Home than in Foreign. This implies that international trade leads to specialization of production. Home concentrates in the production of the skill-intensive good and Foreign concentrates in the production of the unskilled-intensive good.

At the aggregate level trade is balanced, but this is not true for each specific sectors. In the following discussion of the results, we will call the sector, in which a country specializes, its exporting sector, because in that sector it produces more than it consumes. We call the other sector the import-competing sector, because in it the country consumes more than it produces. Each country finances the trade deficit in one sector with the trade surplus in the other sector.

We assume that in the long run workers are mobile across sectors. This implies that, for a given skill class, the number of workers adjusts so that wages and hours worked are equalized across sectors. In the short run workers are immobile across sectors. This implies, that in response to temporary shocks wages and hours worked can differ across sectors. The wage of skilled workers is higher than the wage of unskilled workers because they are assumed be scarcer. As discussed in LM, this can be rationalized by a training technology that makes the acquisition of skills costly.

4.1 Productivity shock at Home

For the first experiment we assume that the aggregate productivity of Home decreases on impact by 1% and then slowly converges back to its steady state level with an autocorrelation of 0.95. The productivity shock affects both sectors equally, i.e., it is not sector-specific. Figure 2 shows the effects of this shock on selected sector-specific variables at Home, e.g., output in the exporting sector versus output in the import-competing sector. Variables are expressed as percent deviations from their steady state values.

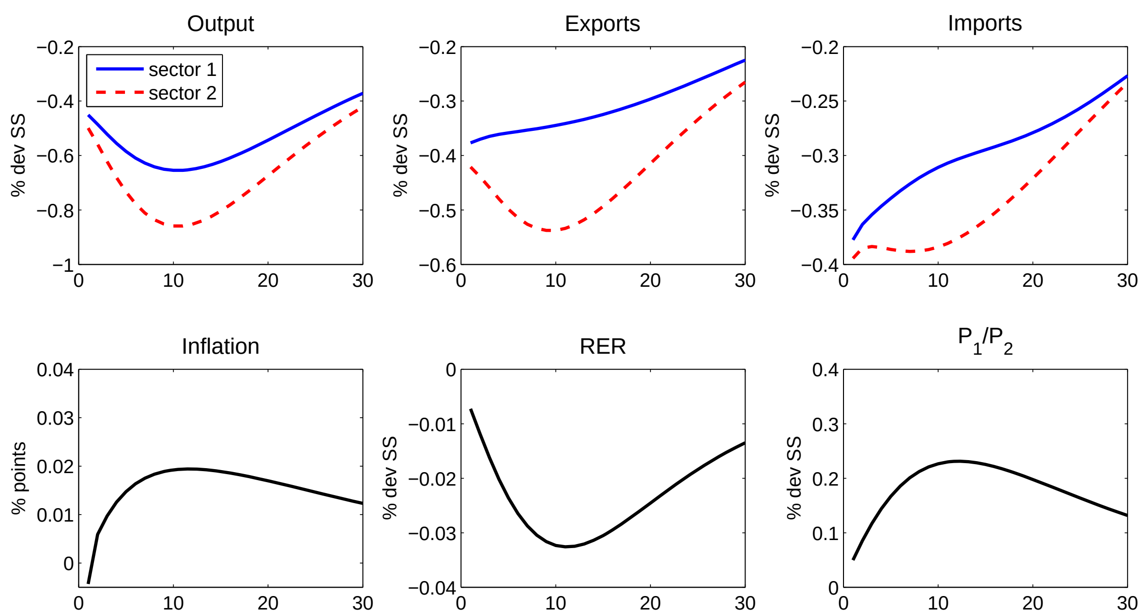

Figure 2: Productivity shock at Home
Specialization

Specialization. As usual a negative productivity shock leads to a contraction in output because production becomes less efficient and so marginal costs and prices rise. Output contracts in both sectors but the contraction is much larger for the import-competing sector than for the exporting sector, so that the production of output becomes more concentrated in the exporting sector. Thus, the temporary fall in Home productivity leads to a temporary increase in specialization.

The second panel of figure 2 shows that the degree of specialization is driven by the movement in relative prices. The fall in productivity leads to an increase in the price level at Home relative to Foreign so that the real exchange rate appreciates and the terms of trade increase. The real exchange rate appreciates for two reasons. First, the fall in productivity makes Home production less efficient and the Home country less willing to supply exports unless the price of its own goods increases relative to the price of foreign goods. Second, Home income falls and the Home country is less willing to demand imports unless the price of foreign goods falls relative to the price of Home goods. As in the standard Heckscher-Ohlin model an increase in the terms of trade translates into an increase in specialization. Our model is a bit more complicated since it incorporates both inter- and intra-industry trade, but the basic mechanism remains intact. In the standard Heckscher-Ohlin model the exporting sector only exports and does not import, while import-competing sector only imports and does not export. This is different in our model due to the co-existence of comparative advantage and love of variety, but it is still the case that exports are more concentrated in the exporting sector. Because Home has specialized its production in the exporting sector, the price level in this sector depends more on the price level of Home than on the price level of Foreign and vice versa for the import-competing sector. As a consequence, the appreciation in the real exchange rate implies a rise in the price of the exporting sector relative to the import-competing sector (P_1/P_2 for the Home country), implying that specialization is enhanced.

Hours. Figure 3 shows that hours worked go down for both skilled and unskilled workers. The supply of hours depends on the ratio of the real wage and the marginal utility from consumption. As figure 3 shows the decrease in productivity lowers the real wage which decreases incentives to supply labor. However, consumption goes down, marginal utility from consumption goes up, which increases the incentives to supply labor. Under log-utlity and in the absence of saving these two effects would cancel each other. However, in our model there are two kinds of saving, investment in new plants and bonds that are traded among households, both nationally and internationally. Similarly to investment in capital in a standard RBC-model , investment in new plants can serve to transfer consumption across periods. In response to the negative productivity shock investment in new plants goes down. This helps to smooth consumption across periods and implies that the drop in consumption is relatively smaller than the drop in real wages. Consequently, hours worked go down for everyone.

Note that the hours worked of unskilled workers go down disproportionately more than those of skilled workers. This is due to the assumption that all workers own equal shares in the firms. Since unskilled workers have lower wage income than skilled workers, this implies that they get a larger share of their income from the firms' profit transfers. They gain disproportionately from the temporary reduction in plant investment that increases these transfers (lower investment means that more profits are distributed rather than reinvested). Their consumption relative to the wage goes down by less compared to skilled workers and consequently they reduce their labor supply by more than skilled workers.

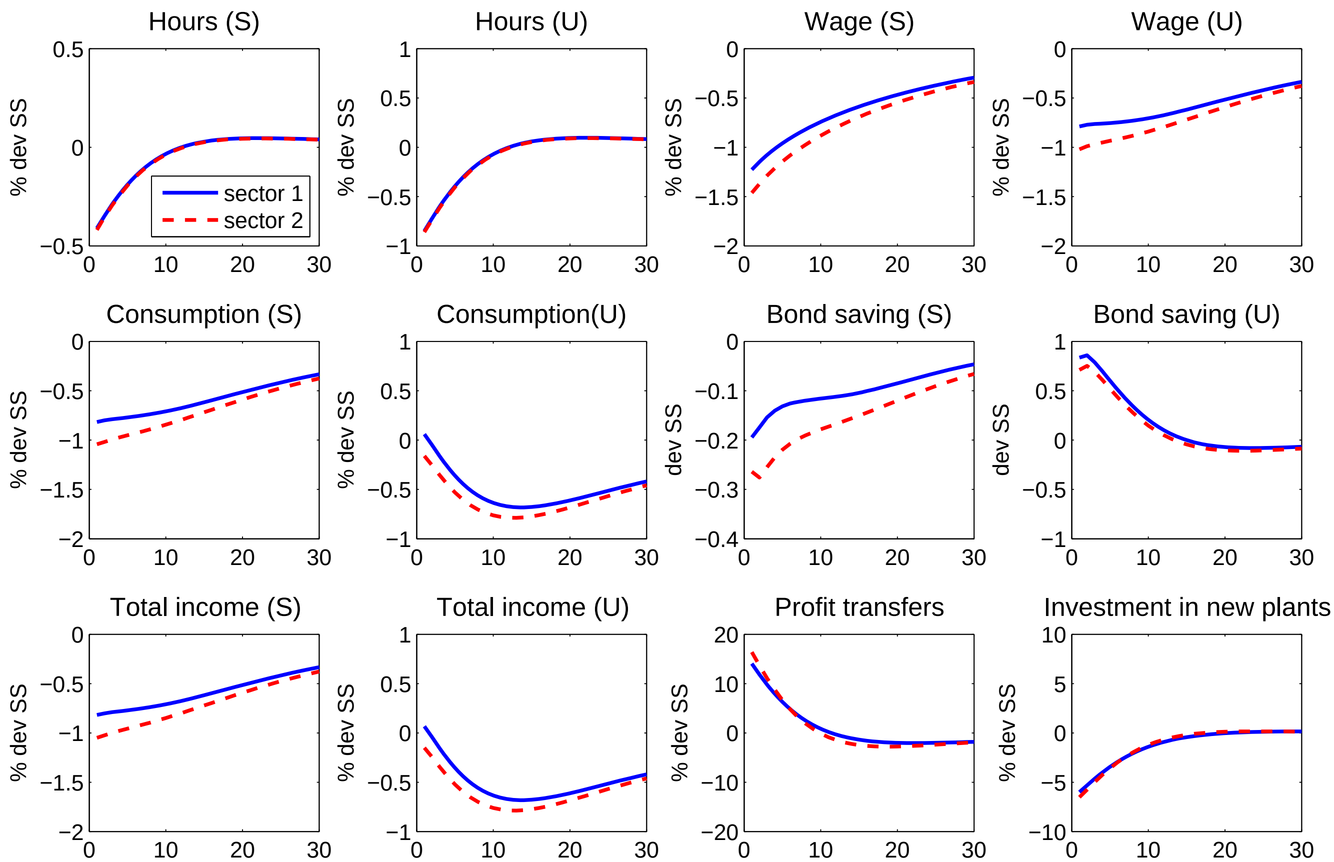

Figure 3: Productivity shock at Home
Hours
S refers to skilled and U to unskilled labor.

Through the exchange of bonds across households aggregate consumption cannot be transferred across periods, but consumption can be 'redistributed' across households. In immediate response to the negative productivity shocks the low-skilled households lend and the high-skilled households borrow. This is due to the fact that the skilled workers face a larger drop in their total income (relative to steady state) than the unskilled.[4] This counteracts the different developments in labor supply. However, the importance of bond saving is rather minor, compared to profit transfers. This is demonstrated by an experiment in which we assume that the firms belong only to the skilled workers. In this scenario, as figure 4 illustrates, the labor supply of unskilled workers is basically flat, while the labor supply of skilled workers goes down considerably. This shows that the development in labor supply is mainly explained by the reduction in plant investment and the relative importance of distributed profits for household income.

[4]Again this is due to the increase in profit transfers that are more important for unskilled workers.

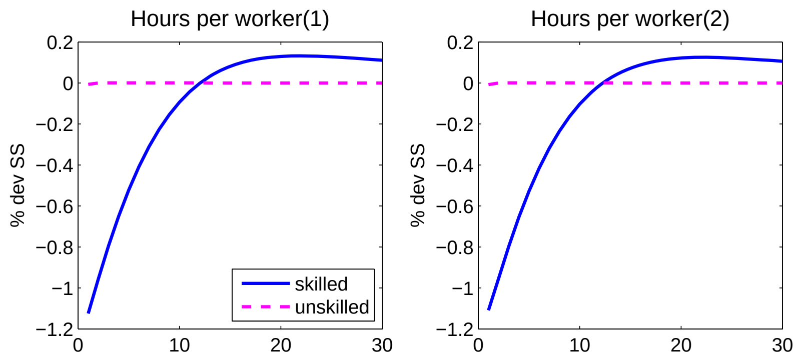

Figure 4: Productivity shock at Home
Only skilled workers own firms.
1 refers to the export sector and 2 refers to the import sector.

Inequality. One of the advantages of our model, in deviating from the standard representative household framework, is that it allows us to discuss inequality across various margins. Figure 5 shows the development of wage and income differences across sectors, across skill classes and in the whole economy.

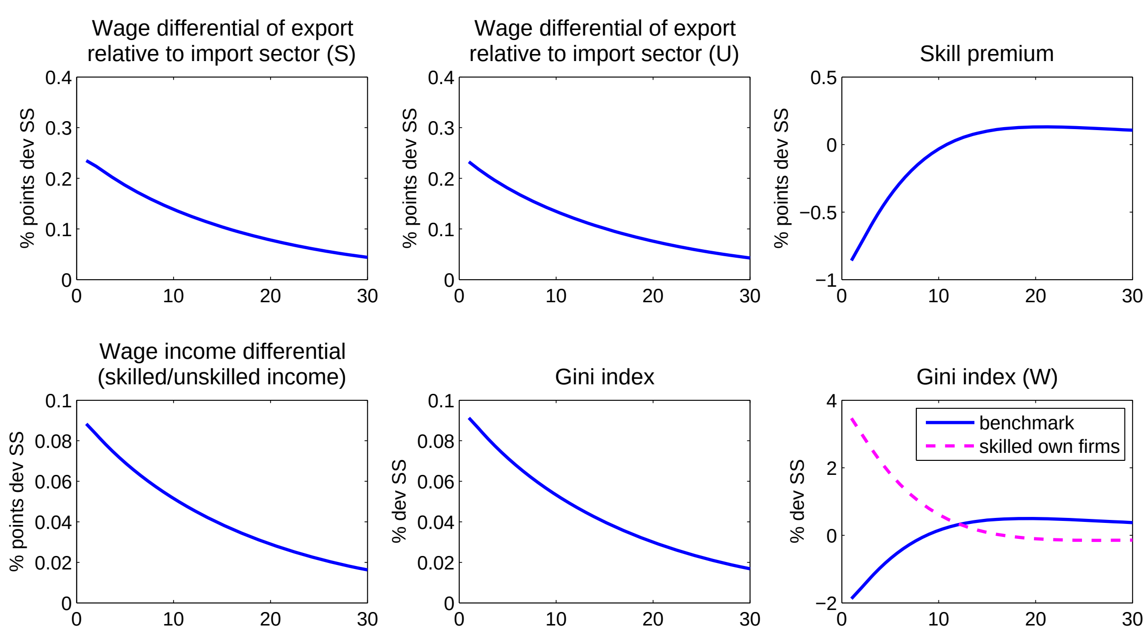

Figure 5: Productivity shock at Home
Inequality

As discussed above, the negative productivity shock leads to a contraction in output in both sectors, but the contraction is larger in the import-competing sector, due to changes in relative prices that favor the exporting sector. This development is also reflected in wages. First, for both skill classes, wages in the import-competing sector drop by more than in the exporting sector, which increases the wage in the exporting sector relative to the wage in the import-competing sector. Sector inequality goes up.

Second, the enhanced specialization in the exporting sector favors skilled workers, the factor that is used more intensively in that sector. This results in an increase the share of wage income that goes to the skilled workers. Note, however, that the picture is different if one only looks at the skill premium which is based on the hourly wage (and not total wage income). Surprisingly, the skill premium goes down meaning that the wage of skilled workers drops by more than the wage of unskilled workers. This is explained by the supply-side of labor. Unskilled workers reduce their labor supply considerably more than skilled workers. This makes unskilled workers relatively scarcer, and reduces the productivity of skilled workers, thus lowering the skill premium.

Overall wage inequality is measured by the Gini coefficient, which is based on the deviation of income from a totally equal distribution. Since sectoral wage inequality increases and a larger share of income goes to skilled workers, the Gini coefficient also increases. The increase is not large but noticeable. The Gini coefficient is purely based on income and thus an imperfect measure for welfare considerations. Therefore, we calculate an equivalent measure based on the utility of workers which includes the dis-utility of labor. The welfare-based Gini goes down by almost 2% on impact. Underlying this development is the fact that the utility of the skilled workers falls as a result of the drop in their consumption which overwhelms the slight fall in the dis-utility of labor from supplying fewer hours. The unskilled workers, on the other hand, gain in terms of utility as they only experience a slight drop in consumption utility while their dis-utility from labor drops a lot as they supply much less labor than the skilled workers. Note that this result relies on the assumption that all workers own the firms. When we assume that the skilled workers are the sole owners of the firms, they benefit as their consumption utility increases due to increased transfers from the firms while the unskilled suffer a drop in utility due to the decreased consumption and wage income after the drop in productivity.

Comparative advantage and trade. So far the discussion has been focused on the disaggregate effects in both sectors and on comparative advantage. Next, we consider the aggregate effects. To put the discussion into perspective we compare our baseline model to i) the same model with two sectors under autarky and ii) to a one-sector version of the model under trade.

Figure 6 compares versions of the two-sector economy both under autarky and under trade. The comparison of both economies illustrates the change in business cycle dynamics that follows from the opening up of trade between an industrialized country and a developed country. International trade partly cushions the economy against domestic shocks. Especially the drop in output on impact of the shock is considerably lower in the scenario with trade. The increase in inflation is more delayed and less pronounced. The lower reaction of output and inflation in response to domestic shocks does of course not necessarily imply that business cycle volatilities are reduced, because an open economy is also subject to foreign shocks.

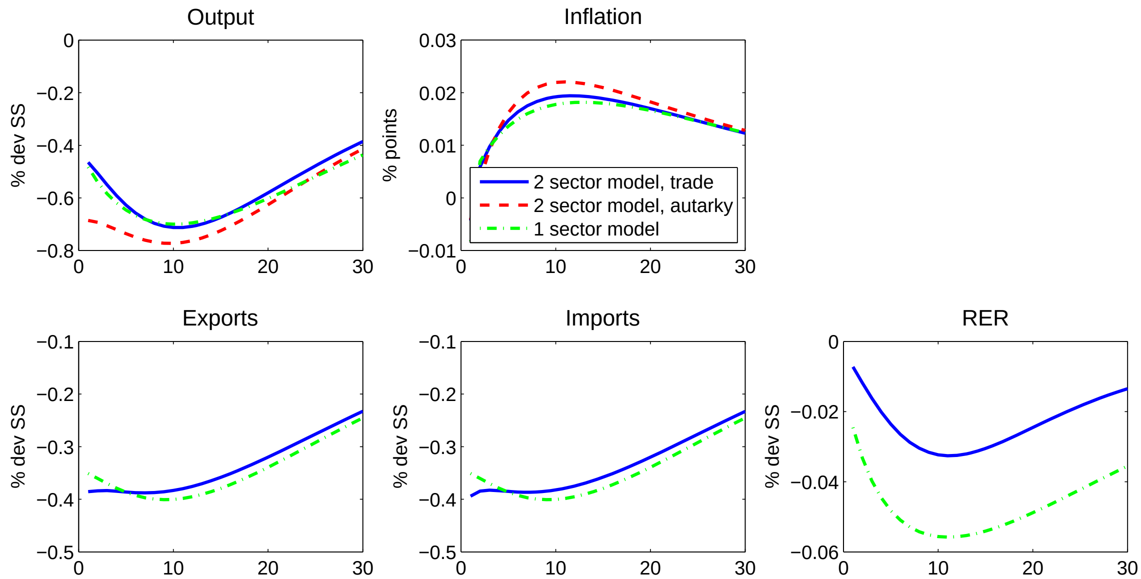

Figure 6: Productivity shock at Home
Comparison between 2 sector model with inter-industry trade,
2 sector model under autarky
and 1 sector model with intra-industry trade

Figure 6 also shows impulse responses for an economy with only one sector. In a one sector economy comparative advantage is absent and international trade is purely intra-industry trade, based on love of variety. The one-sector economy is calibrated such that Home's GDP is the same as in the two-sector economy. The comparison of both economies reveals interesting insights. The volatility of output and inflation is about the same in both economies. Thus, the lower volatility of output and inflation of the benchmark relative to the two-sector model under autarky comes from international trade per se and not from comparative advantage. The presence of comparative advantage does not significantly alter the dynamics of aggregate output and inflation. However, this is not true for the trade-related variables. Imports and exports, and especially the real exchange rate, are much less volatile in the two-sector model. Trade that is based on comparative advantage and sectoral differences is less likely to respond strongly to business cycle shocks.

4.2 Productivity shocks at Foreign

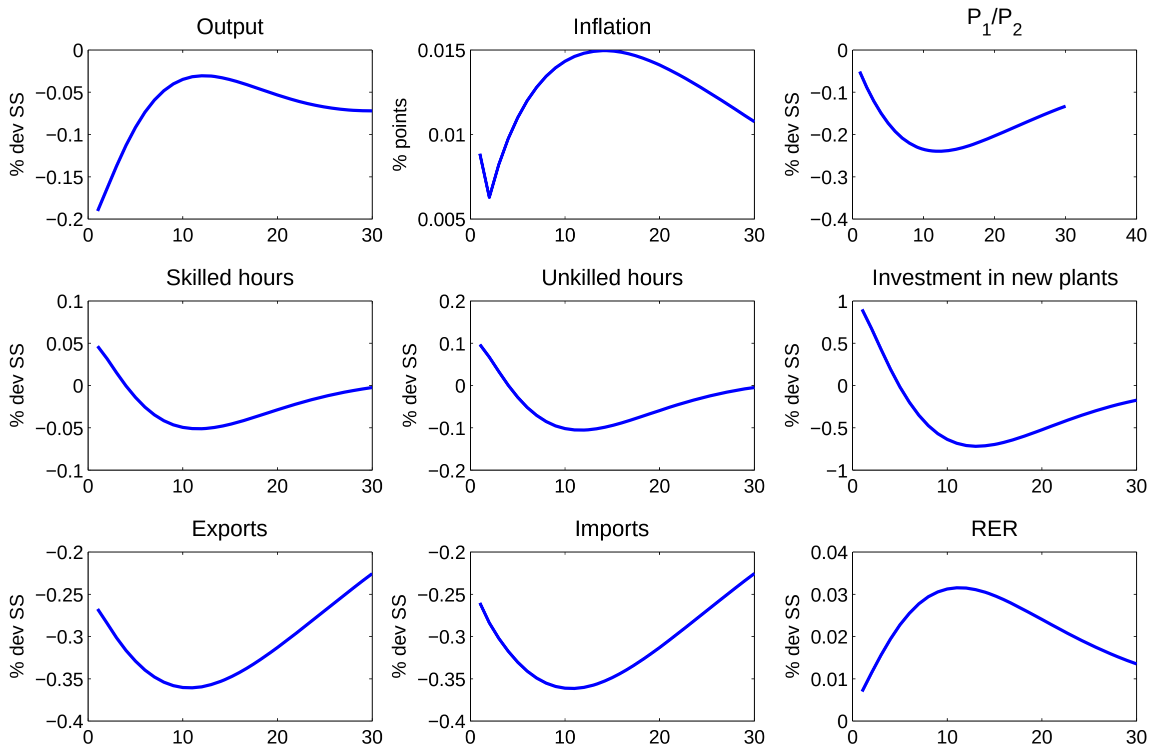

Figure 7: Productivity shock at Foreign
Spillovers to Home country

Figure 7 shows the effects of a temporary productivity shock at Foreign for the economy at Home. As expected, in terms of sector-specialization the effects are exactly the opposite to the productivity shock at Home. The reduced productivity at Foreign leads to lower import-demand at Foreign and lower export-supply of Foreign. As discussed above this implies an improvement of the terms of trade and a real exchange rate appreciation of the country where the shock takes place. For Home then the terms of trade must worsen and the real exchange rate depreciate. This implies that Home's specialization in the skill-intensive sector is reduced to a certain extent, i.e., its exporting sector contracts by more than its import-competing sector.

Households try to smooth their consumption and therefore increase investment in new plants. In the short run this raises the hours worked even though the production of consumption goods (i.e., not taking account of plant investment) contracts. In the medium run, investment in new plants is reduced and with it hours worked. Again the hours worked of the unskilled workers are more volatile than the hours worked of the skilled workers, because the firm's profit transfers make up a bigger part of their income.

Figure 8: Productivity shock at Foreign
Inequality

As figure8 illustrates, wage inequality is again driven by the pattern of specialization. Reduced specialization in the exporting sector implies lower relative demand for labor in the exporting sector and higher wages in the import-competing sector relative to the exporting sector. Reduced specialization in the exporting sector also reduces the share of income that goes to the skilled workers, the factor of production that is more important in the exporting sector. However, the skill premium rises in the very short run which is due to the fact that it is only based on hourly wages and does not take account of the fact that unskilled workers increase their labor supply of hours by more than the skilled workers. This reduces their productivity and therefore the skill premium goes up. Thus, in response to a temporary productivity shock at Foreign the two sources of wage inequality work in opposite direction (this is different for the productivity shock at Home). In this example the increase in sectoral inequality dominates the reduction in the skill premium, so that overall wage inequality as measured by the Gini coefficient goes up, if only a little. The Gini index that measures welfare inequality goes up. This is different from the Home productivity shock case where it went down. Again, this is driven by the dis-utility of labor and hours worked, which increase by more for unskilled workers.

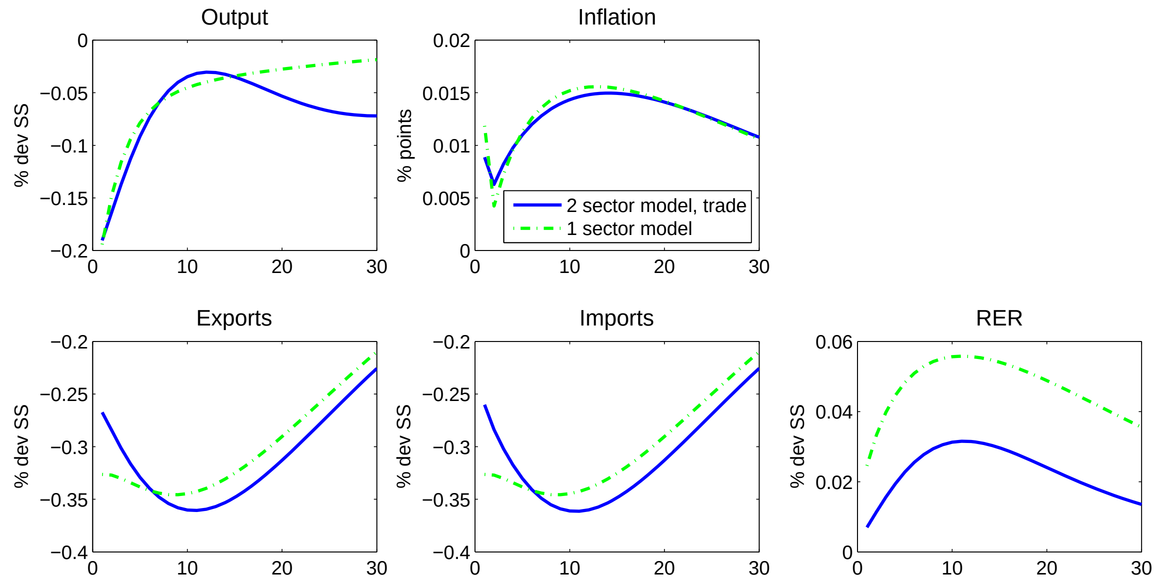

Figure 9: Productivity shock at Foreign
Comparison between 2 sector model with inter-industry trade
and 1 sector model with intra-industry trade

Figure 9 compares the development in our benchmark economy with a one-sector model in which trade is based solely on intra-industry trade. Again the development of aggregate output and inflation is very similar in both economies, while the trade variables differ substantially. The depreciation in the real exchange rate is much larger in the one-sector model (whereas it was the other way around for the productivity shock at Home). As a consequence exports and imports also react much more in the short run even though this overturns in the medium run.

Thus, the introduction of inter-industry trade implies some interesting deviations from the traditional model based on intra-industry trade. Qualitatively the patterns of trade variables are the exact opposite between a productivity shock at Home and a productivity shock at Foreign. Trade based on comparative advantage implies higher exchange rate volatility in response to domestic productivity shocks but lower exchange rate volatility in response to foreign shocks. Similarly, in the short run exports and imports are more responsive to domestic shocks and less responsive to foreign shocks.

5 Conclusion

Industrialized countries increasingly trade with developing countries. The nature of that trade is based on comparative advantage and inter-industry trade. This motivated us to build a two-country two sector DSGE model and analyze how this type of trade affects business cycle dynamics in developed countries. We assume that the developed country, Home, has a higher relative endowment of skilled labor than the developing country, Foreign. Since one sector is skill intensive, the Home country has a comparative advantage in producing this skill-intensive good while the Foreign country has a comparative advantage in producing the other good. Our model also features endogenous firm entry and love-of-variety within each sector. The presence of sticky prices also allows us to analyze the implications of trade on inflation dynamics over the business cycle.

We analyze the consequences of country-specific aggregate productivity shocks. We find that a negative productivity shock at Home temporarily increases specialization in the exporting (skill-intensive) sector because it increases the price of the exporting sector relative to the import-competing sector. At the sector level, we observe a larger contraction of output in the import-competing sector than in the exporting sector as well as larger contraction in the hours of unskilled labor than in the hours of skilled labor. At the aggregate level, however, the different developments in both sectors seem to largely wash out. Compared to a corresponding one-sector economy, aggregate output and inflation do not show significant differences. However, aggregate trade flows and the real exchange rate are less volatile in the two-sector economy.

The different developments at the sector level, however, do have implications for inequality. The increased specialization in the skill-intensive sector raises the demand for skilled workers relative to unskilled workers, and as a result a larger share of total wage payments goes to the skilled workers. At the same time wages in the comparative-advantage sector increase relative to the comparative-disadvantage sector. Both effects tend to raise total income inequality as measured by the Gini coefficient, although the effects are not large.

We also find that our model economy generates sizable spillovers across countries. In response to a negative productivity shock in the developing country aggregate output in the industrialized country contracts by almost half as much as in response to domestic shocks. The real exchange rate depreciates which leads to a temporary reduction in specialization in the industrialized country. Again, this has implications for inequality. The share of wage payments that goes to skilled workers goes down, while wage inequality across sectors goes up. The effects counteract each other, resulting in a tiny increase in overall wage inequality.

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