Skill Premium Divergence: The Roles of Trade, Capital and Demographics

Sang-Wook (Stanley) Cho

School of Economics, University of New South Wales, Sydney, 2052, NSW, Australia

Julián P. Díaz

Department of Economics, Quinlan School of Business, Loyola University Chicago, 820 N. Michigan Avenue, Chicago, IL 60611

Abstract

We construct an applied general equilibrium model to account for diverging patterns of the skill premium. Our framework assesses the roles of various factors that affect the demand and supply of skilled and unskilled labor—shifts in the skill composition of the labor supply, changes in the terms of trade and the complementarity between skilled labor and equipment capital in production. We find that increases in relative skilled labor supply due to demographic changes lead to a decline in the skill premium, while equipment capital deepening raises the relative demand for skilled labor which in turn increases the skill premium. In addition, terms of trade changes lead to the reallocation of resources towards sectors in which countries enjoy comparative advantages. Since our model incorporates multiple factors simultaneously, it can generate either rising or falling skill premium paths. When we parametrize the model to the Baltic states—countries that were similar along many dimensions at the onset of their transition from centrally-planned to market-oriented economies—our model can closely account for the diverging patterns of skill premia for the period between 1995 and 2008.

JEL classification: E16, E25, J24, J31

Keywords: skill premium, international trade, capital-skill complementarity, demographic change, Baltic states

Email addresses: `s.cho@unsw.edu.au` (Sang-Wook (Stanley) Cho), `jdiaz17@luc.edu` (Julián P. Díaz)

1. Introduction

Because of their implications on income inequality, the patterns of the skill premium—defined as the wage of skilled labor relative to that of unskilled labor—have received a considerable amount of attention in the Economics literature in the recent years. Indeed, a vast number of articles have been written on the topic, documenting and accounting for skill premium trends across developed and developing economies.[1]

Although no unanimous consensus has yet been reached on which factors definitively drive the movements of the skill premium, a few hypotheses have emerged as prime candidates: technological change that favors skilled workers because they are complementary to capital; the expansion of trade that encourages production in sectors that use a particular type of labor intensively; and the abundance of skilled labor relative to unskilled labor. However, a common shortcoming of a vast array of articles dealing with the subject is that they focus on the effects of one single factor on the skill premium, thus neglecting the potential interactions of the other explanations.

To address this issue, we propose a static general equilibrium model that can embody all three factors simultaneously. Our choice of a static model over a dynamic one is due to our first-order interest in understanding how capital, trade and skill abundance factors affect the skill premium individually and jointly, rather than understanding why those factors evolved in the way they did. The model features a multi-sector small open economy that trades with the rest of the world, with productive sectors that utilize skilled and unskilled labor with different skill intensities. Thus, terms of trade shocks that, for example, promote increased production in a sector with a particular level of skill intensity will have further effects on the skill premium. Moreover, the domestic production technology displays complementarity between equipment capital and skilled labor, so episodes of rapid capital expansion will biasedly benefit skilled workers and increase their wages. Finally, our model also includes labor supply decisions for both types of workers, so increases or decreases in the different types of labor supply (resulting from demographic changes) that alter their relative abundances will in turn be reflected on the skill premium.

Using the first order conditions derived from the optimizing behavior of the agents in our model, we can analytically decompose the growth of skill premium into three terms. The first one implies that the relative growth rates of equipment capital and skilled labor are positively

[1] While the behavior of the skill premium is a heavily-researched topic, the definition of "skill" is not standard in the literature and has been used to label the occupation, sector, or even tenure of different types of workers. In this article, we follow Goldin and Katz (2008) and Krusell et al. (2000) and use the educational-attainment definition of skill: skilled workers are those with tertiary (or college) education, while unskilled workers are those with non-tertiary education.

correlated with the skill premium; the second implies that the relative growth rates of skilled labor and unskilled labor are negatively correlated with the skill premium; finally, the third term embodies the Heckscher-Ohlin (H-O) mechanism, where reductions in trade costs lead to factor reallocation towards the sectors where the country enjoys comparative advantages, and thus raise the relative return to the factor that is more intensively used in those sectors. In that sense, our model allows us to explore labor demand *and* labor supply implications on relative wages and therefore the skill premium.

Since our model incorporates multiple factors at the same time, their overall effect could theoretically lead to skill premium increases or decreases. To assess whether our model generates predictions that are in line with actual data observations, we apply it to account for the patterns of the skill premium in the Baltic states: Estonia, Latvia and Lithuania. These countries represent an interesting application because of at least two reasons. First, as these republics transitioned from centrally-planned to free-market systems, they aggressively opened their economies to the rest of the world, accumulated massive amounts of capital stock, and experienced significant changes in the skill composition of their labor forces. So all three factors that we include in our model were actively operating in their economies. Second, despite many similarities in their economies at the onset of their transition, their skill premia followed very different patterns. Indeed, between 1995 and 2008, the skill premium in Latvia increased by nearly 16%, while in Estonia and Lithuania it declined by 20% and 13%, respectively.

When we calibrate our model to match Baltic data and conduct comparative statics experiments that replicate the paths of capital stock accumulation, terms of trade and changes in the relative skill composition of the labor force that the Baltic states experienced, our model predicts decreases in the Estonian and Lithuanian skill premium of 22% and 35%, respectively, and an increase in the Latvian skill premium of 10%. Therefore, our model produces skill premium movements that are consistent with those observed in the Baltics, both qualitatively and quantitatively.

Our results indicate that the divergence of skill premium in the Baltics is the result of forces that affect skill premium in opposite directions. More specifically, we find that the changes in demographics—through increases in relative skill supply—lead to a decline in the skill premium, while equipment capital deepening raises the relative demand for skilled labor and thus increases the skill premium. In addition, favorable terms of trade lead to the reallocation of factors towards sectors in which the transition economies have comparative advantages. As the Baltic states have a comparative advantage in unskilled-intensive sectors, the cross-sector reallocation of resources lowers the skill premium. All in all, our model suggests that in Estonia and Lithuania, the forces that lower skill premium dominated the force that raises it, whereas in Latvia the opposite effect took place.

Thus, our contribution to the literature consists in a unified framework that simultaneously incorporates both labor demand and supply factors to account for skill premium changes. In a recent article, Parro (2013) constructs a static quantitative model of trade and finds that when the capital-skill complementarity channel is included, reductions in the cost of capital goods due to technological progress and in trade costs lead to increases the skill premium for a sample of developed and developing countries. His model, however, generates only skill premium increases, even for countries that experienced declines in the skilled relative wage. Our model, on the other hand, yields increases and decreases in the skill premium because it includes labor supply effects that sometimes can overcome the labor demand effects that are biased towards skilled workers. Ripoll (2005), on the other hand, constructs a dynamic general equilibrium model that features trade shocks and skill accumulation choices—though not capital-skill complementarity—to analyze the patterns of the skill premium in developing economies. Her model is able to generate skill premium series that exhibit increasing or decreasing paths, but those trends are due to differences in initial conditions across countries in terms of human and physical capital stocks. Our model, instead, produces diverging skill premium paths for economies that were initially quite similar on those dimensions. Moreover, our model fits the Baltic data fairly well, while Ripoll's study is purely theoretical.

The rest of the paper is organized as follows. Section 2 presents the evolution of skill premium patterns as well as a brief overview of the economies of the Baltic states. Section 3 describes the general equilibrium model and the analytical derivation of skill premium implied by the model. Section 4 details the calibration of the model and Section 5 describes the numerical experiments we conduct and the results we obtain. In Section 6 we check the robustness of our results by running a series of sensitivity analyses, including one where we assess the predictions generated by our model in shorter horizons. We conclude in Section 7.

2. A Brief Overview of the Baltic States' Economies

2.1. The Skill Premium

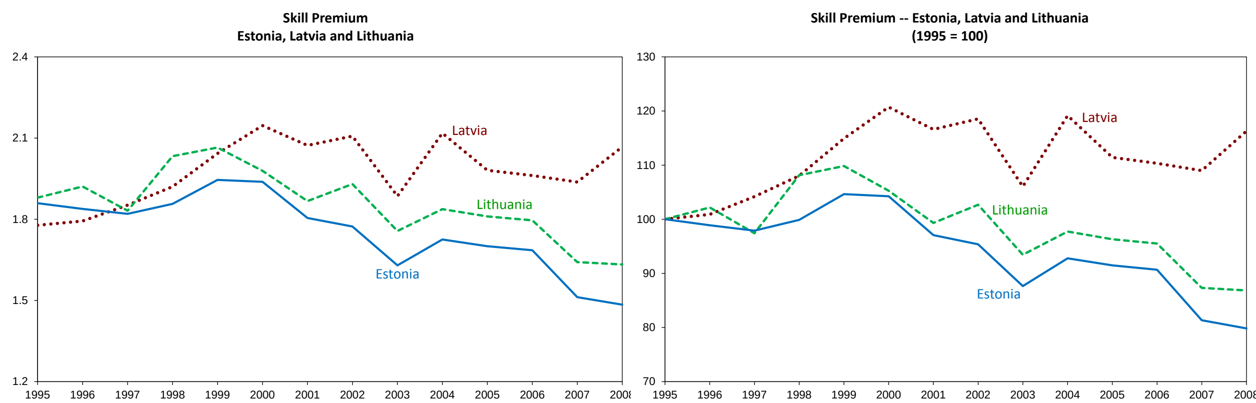
We construct skill premium series using the data in the Socio Economic Accounts (SEA) section of the World Input Output Database (WIOD). Our definition of skill is educational attainment: skilled workers are those who have tertiary education, while unskilled workers are those who do not. The SEA database does not contain readily-available skill premium series for the Baltic states, but it includes series of both labor compensation and hours worked, disaggregated by skill levels. This allows us to back out the skill premium series using the fact that:

$$\text{skill premium} = \frac{w_s}{w_u} = \frac{\frac{w_s \ell_s}{\ell_s}}{\frac{w_u \ell_u}{\ell_u}} \quad (1)$$

where ℓ_s and ℓ_u are hours worked by skilled and unskilled labor, and $w_s\ell_s$ and $w_u\ell_u$ are skilled and unskilled labor compensation, all of which are available in the WIOD.

The constructed skill premium series start in 1995, the first year of data availability in the WIOD, and end in 2008, the year prior to the international financial crisis. They are shown in Figure 1, both in absolute terms and also normalized so that they take the value of 100 in the initial year, to facilitate comparisons.

Figure 1



A few facts are worth noting: the first one is that in 1995, the skill premium exhibited quite similar values in all three Baltic states. Second, in spite of this initial similarity, the Baltic skill premia took divergent paths: by 2008, the skill premium in Latvia had increased by approximately 16% relative to its 1995 value, while the skill premium in Estonia and Lithuania had declined by around 20% and 13% during the same period, respectively.

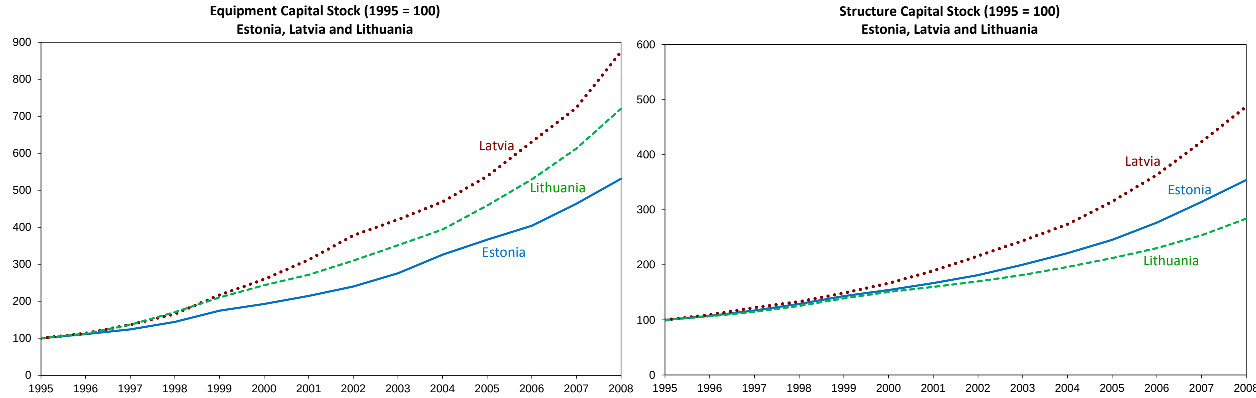
2.2. The Stock of Capital

As documented in Bems and Jönsson Hartelius (2006), upon their independence the Baltic states were capital-poor economies when compared with their peers in the European Union. Since then, they have all expanded their stocks of capital quickly, both in the form of structures and of equipment.

Using the OECD National Accounts database, we construct time series for equipment and structure capital stock for Estonia, Latvia and Lithuania.[2] We find that, while in all

[2]In Section 5 we explain in more detail how we construct the capital stock series.

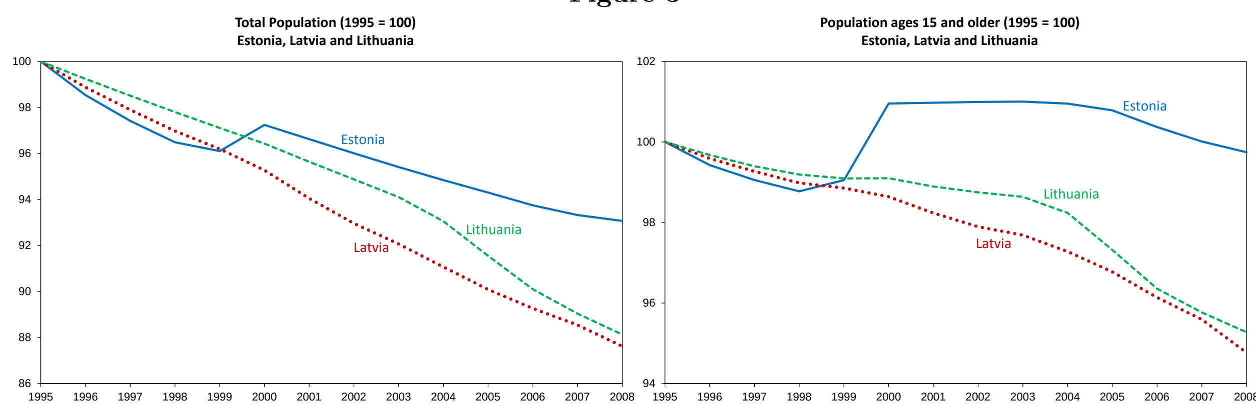
Figure 2



three countries both types of capital grew at very fast rates, Latvia displays the highest growth rate of equipment capital stock, which is the type of capital that is considered to be complementary to skilled labor. Moreover, the share of equipment capital in the total stock of capital is also the highest in Latvia.

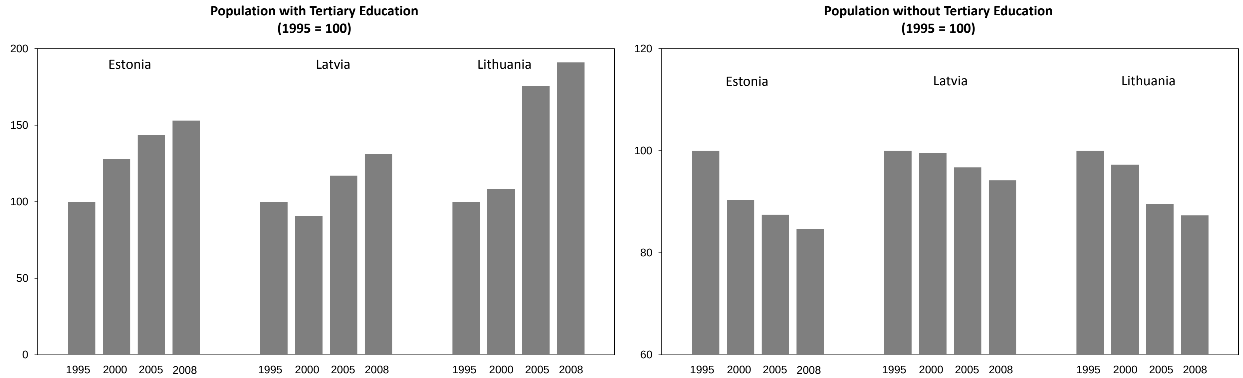
2.3. Skill Composition of the Population

Figure 3



The populations of the Baltic states are among the lowest in the European Union, with Estonia's population slightly exceeding 1 million, and Latvia and Lithuania surpassing the 2- and 3-million mark, respectively. As Figure 3 shows, all three countries exhibited a persistent population decline: between 1995-2008, Estonia's population shrank by 7%, while Latvia's and Lithuania's population declined by approximately 12%. For Latvia and Lithuania, the decline in total population is coupled with a decline in the population aged 15 and above (which includes those who are of working age), that by 2008 had decreased by nearly 5% relative to their levels in 1995. In Estonia, this segment of the population remained relatively constant, with small fluctuations above and below the 1995 levels.[3]

Figure 4



Additionally, as depicted in Figure 4, the skill composition of the Baltic population changed substantially, with the population with tertiary education rising and those without it declining. The Barro and Lee (2013) database reveals that the changes in the composition of population aged 15 and older were uneven across the Baltics—Lithuania displayed the largest increase in the skilled population, followed by Estonia and Latvia, in that order. On the other hand, Latvia recorded the smallest decline in the unskilled population, followed by Lithuania and Estonia.[4]

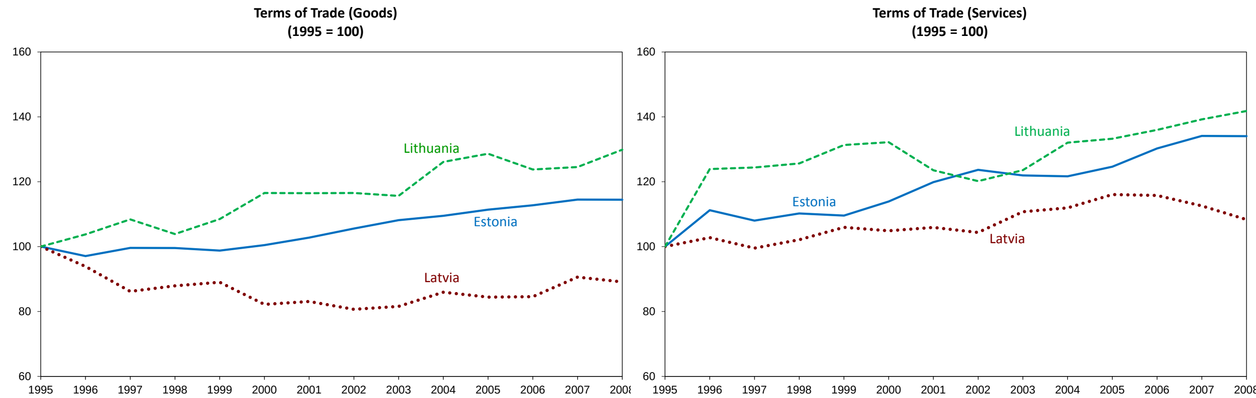
2.4. The Foreign Sector

The three Baltic states have displayed high degrees of openness—measured as the ratio of total trade relative to GDP—ever since opening their economies. As small and very open economies, the Baltics are obviously exposed to variations in their terms of trade (defined as the ratio of export prices to import prices). Using the Annual Macro-economic Database (AMECO) compiled by the European Commission, we calculate the series of terms of trade for goods and for services during the 1995-2008 period. A clear divergent pattern is evident for the goods terms of trade, as Estonia and Lithuania experienced improvements in the terms of trade, whereas Latvia experienced declines. On the other hand, all three countries experienced improvements in the terms of trade in the services sector, but the magnitude of such improvements is much larger for Estonia and Lithuania than for Latvia (see Figure 5).

[3]Data are taken from the World Bank's World Development Indicators database.

[4]The Barro and Lee (2013) database reports statistics in 5-year intervals. For the period we analyze, the database provides information for the years 1995, 2000, 2005 and 2010. The values for the year 2008 were calculated by linear interpolation.

Figure 5



3. Model

Having established these facts, we now build a static general equilibrium model with endogenous labor-leisure decisions, international trade, and complementarity between skilled labor and equipment capital in production. The economy we construct is composed of two countries: a Baltic state—Estonia, Latvia or Lithuania—and the rest of the world. We impose the small-economy assumption on the Baltic states, meaning that they are so small that they cannot affect foreign prices and take them as exogenous. Moreover, each Baltic economy is populated by several agents: two representative households (differentiated by their skills levels), producers, and a domestic government. Since our focus is on the Baltics, the rest of the world is modeled in simpler detail. The preferences and technologies of the agents in our model, as well as the way agents interact with each other, are described below.

3.1. Production

Two commodities are produced in each Baltic economy: goods (G) and services (S). We denote the set of commodities by I. Each commodity $i \in I$ is made up of a domestic component $y_{d,i}$ and a foreign component $y_{f,i}$ which is imported from the same sector in the rest of the world. The domestic and imported components are combined using an Armington aggregator of the form:

$$y_i = \phi_i \left[\delta_i y_{d,i}^{\rho_{m,i}} + (1-\delta_i) y_{f,i}^{\rho_{m,i}} \right]^{\frac{1}{\rho_{m,i}}} \tag{2}$$

where $\rho_{m,i}$ is the parameter that governs the elasticity of substitution between domestic and imported components in sector i, δ_i is the parameter which governs the share of imports in the production of commodity i, and ϕ_i is the parameter that reflects the level of productivity in the final goods production in sector i. Imports of commodity i are purchased at the international price $\bar{p}_{f,i}$, which the Baltic states take as given, and are subject to an ad-valorem tariff rate $\tau_{f,i}$, while purchases of the domestic component are subject to a production tax rate t_i.

3.2. Domestic Component Producer

The domestic component $y_{d,i}$ is produced using intermediate inputs from all sectors $x_{j,i}$ in fixed proportions, capital structures and equipment $k_{z,i}$ and $k_{e,i}$, and skilled and unskilled labor $\ell_{s,i}$ and $\ell_{u,i}$:

$$y_{d,i} = \min\left\{\frac{x_{1,i}}{a_{1,i}}, \ldots, \frac{x_{n,i}}{a_{n,i}}, \beta_i k_{z,i}^{\alpha_i}\left[\lambda_i\left[\mu_i k_{e,i}^{\rho} + (1-\mu_i)\ell_{s,i}^{\rho}\right]^{\frac{\sigma}{\rho}} + (1-\lambda_i)\ell_{u,i}^{\sigma}\right]^{\frac{1-\alpha_i}{\sigma}}\right\} \tag{3}$$

where $a_{j,i}$ is the unit requirement of intermediate input j in the production of commodity i; α_i, μ_i and λ_i are the share parameters of inputs in value added; β_i is the parameter that reflects the level of productivity in the domestic production in sector i; $1/(1-\rho)$ is the elasticity of substitution between equipment and skilled labor; and $1/(1-\sigma)$ is the elasticity of substitution between unskilled labor and equipment or skilled labor. We follow Krusell et al. (2000) in assuming that value added is produced as Cobb-Douglas combination of structures and a CES combination of equipment and skilled and unskilled labor.

3.3. Investment Good

We include an investment good in order to account for the savings observed in the data. In a dynamic model, agents save in order to enjoy future consumption. In a static model like the one we use, agents derive utility from consuming the investment good, just as they derive utility from the consumption goods. The investment good y_{inv} is produced by a firm that combines the final goods as intermediate inputs using a fixed proportions technology, as shown:

$$y_{inv} = \min\left\{\frac{x_{1,inv}}{a_{1,inv}},\ \ldots,\ \frac{x_{i,inv}}{a_{i,inv}},\ \ldots,\ \frac{x_{n,inv}}{a_{n,inv}}\right\} \tag{4}$$

3.4. Households

Each Baltic state is populated by two representative households: skilled (s) and unskilled (u). We denote the set of households by H. Each type of household $j \in H$ chooses consumption, savings and leisure to maximize utility:

$$\left[\zeta_j\left(\sum_{i\in I}\theta_i^j c_{i,j}^{\eta} + \theta_{inv}^j (c_{inv,j} + c_{b,j})^{\eta}\right)^{\frac{\psi}{\eta}} + (1-\zeta_j)(\bar{L}_j - \ell_j)^{\psi}\right]^{\frac{1}{\psi}} \tag{5}$$

subject to the budget constraint

$$\sum_{i \in I} p_i c_{i,j} + p_{inv}(c_{inv,j} + c_{b,j}) = (1 - t_d^j)(w_j \ell_j + r_e \bar{k}_{e,j} + r_z \bar{k}_{z,j})$$

where $c_{i,j}$ is consumption of commodity i by household j and p_i its price; $\bar{L}_j$ is the total number of available hours and ℓ_j is hours worked; $1/(1-\eta)$ is the elasticity of substitution among consumption goods, and $1/(1-\psi)$ is the elasticity of substitution between the consumption aggregate and leisure; θ_i^j and ζ_j are share parameters in household j's preferences; t_d^j is the direct tax rate levied on household j; w_j is the wage rate for skilled or unskilled labor; $\bar{k}_{e,j}$ and $\bar{k}_{z,j}$ are the equipment and structures endowments of household j; and r_e and r_z their respective rental rates.

Additionally, $c_{inv,j}$ denotes the purchases of the investment good by household j and p_{inv} its price. If the government runs a deficit, we assume that it sells government bonds to the households to finance such deficit. Thus, $c_{b,j}$ denotes the purchases of government bonds by household j. We follow Kehoe and Serra-Puche (1983) and assume that households treat government bonds and the investment good as perfect substitutes. Consequently, $c_{inv,j}$ and $c_{b,j}$ account for the savings of household j.

3.5. Government

To account for the government purchases observed in the data, we follow the standard practice in the literature (see Whalley 1982 and Kehoe 1996) and model the government as a utility-maximizing agent that derives utility from consuming production goods and the investment good. The government in each country imposes taxes to finance the purchases of consumption and services $c_{i,g}$. Additionally, if the government runs a surplus, it purchases the investment good, which we denote by $c_{inv,g}$. Government consumption baskets are ranked according to the utility function:

$$\sum_{i \in I} \theta_i^g \log c_{i,g} + \theta_{inv}^g \log c_{inv,g} \tag{6}$$

These purchases must satisfy the government's budget constraint

$$\sum_{i \in I} p_i c_{i,g} + p_{inv} c_{inv,g} = \sum_{j \in H} t_d^j (w_j \ell_j + r_e \bar{k}_{e,j} + r_z \bar{k}_{z,j}) + \sum_{i \in I} t_i p_i y_{d,i} + \sum_{i \in I} e_f \tau_{f,i} \bar{p}_{f,i} y_{f,i} + \sum_{j \in H} p_{inv} c_{b,j}$$

The left-hand side of the budget constraint includes purchases of goods and services, as well as the investment good. The first term in the right-hand side includes the direct taxes levied on the households; the second and third term denote production taxes and tariff revenues, respectively; the last term represents the sales of bonds to the households if the government runs a deficit (if that is the case, $c_{inv,g} = 0$).

3.6. Rest of the World

We model a single representative household in the rest of the world that purchases imported goods $x_{f,i}$ from the Baltics and consumes its own local good $x_{f,f}$ to maximize utility

$$\left[\sum_{i \in I} \theta_i^f x_{f,i}^{\rho_x} + \theta_{inv}^f x_{f,inv}^{\rho_x} + \theta_f^f x_{f,f}^{\rho_x} - 1\right] / \rho_x \tag{7}$$

subject to the budget constraint

$$\sum_{i \in I} (1 + \tau_i^f) p_i x_{f,i} + p_{inv} x_{f,inv} + e x_{f,f} = e I_f$$

where τ_i^f is the ad-valorem tariff rate that the rest of the world imposes on Baltic imports of commodity i; $1/(1-\rho_x)$ is the export elasticity of substitution; I_f is the income in the rest of the world; e is the real exchange rate; and $x_{f,inv}$ are the purchases of the Baltic investment good by the rest of the world, in order to account for the Baltic country's trade deficit (i.e., foreigners saving in the Baltics).

3.7. Definition of Equilibrium

An equilibrium for this economy consists of a set of prices $\{p_i\}_{i \in I}$ for the final goods; $\{p_{d,i}\}_{i \in I}$ for the domestic components; and p_{inv} for the investment good; factor prices w_s, w_u, r_e, r_z; an exchange rate e; foreign prices $\{\bar{p}_{f,i}\}_{i \in I}$; a consumption plan for each type of household j $(\{c_{i,j}\}_{i \in I}, c_{inv,j}, c_{b,j})$; a consumption plan for the government $(\{c_{i,g}\}_{i \in I}, c_{inv,g})$; a consumption plan for the household in the rest of the world $(\{x_{f,i}\}_{i \in I}, x_{f,inv}, x_{f,f})$; a production plan for the domestic-component producer of commodity i $(y_{d,i}, x_{1,i}, ... x_{n,i}, k_{e,i}, k_{z,i}, \ell_{u,i}, \ell_{s,i})$; a production plan for the producer of commodity i $(y_i, y_{d,i}, y_{f,i})$; and a production plan for the investment good firm $(y_{inv}, x_{1,inv}, ..., x_{n,inv})$; such that, given the tax rates and the tariff rates:

(i) The consumption plan $(\{c_{i,j}\}_{i \in I}, c_{inv,j}, c_{b,j})$ maximizes the utility of household j subject to its budget constraint.

(ii) The consumption plan $(\{c_{i,g}\}_{i \in I}, c_{inv,g})$ maximizes the government's utility subject to its budget constraint.

(iii) The consumption plan $(\{x_{f,i}\}_{i \in I}, x_{f,inv}, x_{f,f})$ maximizes the utility of the household in the rest of the world subject to its budget constraint.

(iv) The production plan $(y_{d,i}, x_{1,i}, ...x_{n,i}, k_{e,i}, k_{z,i}, \ell_{u,i}, \ell_{s,i})$ satisfies:

$$\begin{aligned} y_{d,i} &= \min\left\{\frac{x_{1,i}}{a_{1,i}}, \dots, \frac{x_{n,i}}{a_{n,i}}, \beta_i k_{z,i}^{\alpha_i}\left[\lambda_i\left[\mu_i k_{e,i}^{\rho} + (1-\mu_i)\ell_{s,i}^{\rho}\right]^{\frac{\sigma}{\rho}} + (1-\lambda_i)\ell_{u,i}^{\sigma}\right]^{\frac{1-\alpha_i}{\sigma}}\right\} \\ &\text{and } (1-t_{p,i})p_{d,i}y_{d,i} - \sum_{j\in \mathsf{I}} p_j x_{j,i} - w_u\ell_{u,i} - w_s\ell_{s,i} - r_e k_{e,i} - r_z k_{z,i} \le 0, = 0 \text{ if } y_{d,i} > 0 \end{aligned}$$

(iv) The production plan $(y_i, y_{d,i}, y_{f,i})$ satisfies:

$$p_i y_i - p_{d,i}y_{d,i} - (1+\tau_{f,i})e\bar{p}_{f,i}y_{f,i} \le 0, = 0 \text{ if } y_i > 0$$

where $y_{d,i}$ and $y_{f,i}$ solve:

$$\begin{aligned} \min \quad & p_{d,i}y_{d,i} + (1+\tau_{f,i})e\bar{p}_{f,i}y_{f,i} \\ \text{s.t.} \quad & \phi_i\left[\delta_i y_{d,i}^{\rho_{m,i}} + (1-\delta_i y_{f,i}^{\rho_{m,i}}\right]^{\frac{1}{\rho_{m,i}}} = y_i \end{aligned}$$

(vi) The production plan $(y_{inv}, x_{1,inv}, ..., x_{n,inv})$ satisfies:

$$\begin{aligned} y_{inv} &= \min\left\{\frac{x_{1,inv}}{a_{1,inv}}, \ \dots, \frac{x_{i,inv}}{a_{i,inv}}, \ \dots, \frac{x_{n,inv}}{a_{n,inv}}\right\} \\ \text{and } & p_{inv}y_{inv} - \sum_{j\in \mathsf{I}} p_j x_{j,inv} \le 0, = 0 \text{ if } y_{inv} > 0 \end{aligned}$$

(viii) The factor markets clear:

$$\begin{aligned} \sum_{i\in I} \ell_{u,i} &= \ell_u \\ \sum_{i\in I} \ell_{s,i} &= \ell_s \\ \sum_{i\in I} k_{e,i} &= \sum_{j\in H} \bar{k}_{e,j} = \bar{K}_e \\ \sum_{i\in I} k_{z,i} &= \sum_{j\in H} \bar{k}_{z,j} = \bar{K}_z \end{aligned}$$

(ix) The goods markets clear:

$$y_i = \sum_{j \in I} x_{j,i} + x_{i,inv} + \sum_{j \in H} c_{i,j} + c_{i,g} + x_{f,i} \quad \forall i \in I$$

$$y_{inv} = \sum_{j \in H} c_{inv,j} + c_{inv,g} + x_{f,inv}$$

(x) The balance of payments condition is satisfied:

$$\sum_{i \in I} e\bar{p}_{f,i} y_{f,i} = \sum_{i \in I} p_i x_{f,i} + p_{inv} x_{f,inv}$$

3.8. The Skill Premium in the Model

From the first-order conditions of the firm that produces the domestic component $y_{d,i}$, we can derive the expression for the skill premium, which we denote as π:

$$\begin{aligned}
\pi = \frac{w_s}{w_u} &= \frac{\lambda_i(1-\mu_i)}{1-\lambda_i} \left[\mu_i k_{e,i}^{\rho} + (1-\mu_i)\ell_{s,i}^{\rho}\right]^{\frac{\sigma-\rho}{\rho}} \frac{\ell_{s,i}^{\rho-1}}{\ell_{u,i}^{\sigma-1}} \\
&= \frac{\lambda_i(1-\mu_i)}{1-\lambda_i} \left[\mu_i \left(\frac{k_{e,i}}{\ell_{s,i}}\right)^{\rho} + (1-\mu_i)\right]^{\frac{\sigma-\rho}{\rho}} \left(\frac{\ell_{s,i}}{\ell_{u,i}}\right)^{\sigma-1} \qquad (8)
\end{aligned}$$

Log-linearizing (8) and differentiating with respect to time, we obtain the following expression, similar to the one found in Krusell et al. (2000):

$$\gamma_\pi \simeq \mu_i(\sigma-\rho)\left(\frac{k_{e,i}}{\ell_{s,i}}\right)^{\rho}(\gamma_{k_{e,i}} - \gamma_{\ell_{s,i}}) + (\sigma-1)(\gamma_{\ell_{s,i}} - \gamma_{\ell_{u,i}}) \quad \forall i \in I \qquad (9)$$

where γ_x denotes the growth rate of variable x. As in Krusell et al. (2000), the growth rate of skill premium depends on the relative growth rates of equipment capital and skilled labor, captured by the first term in (9), and the relative growth rates of skilled and unskilled labor, captured by the second term. Additionally, as our model includes sectors that differ in their skill intensities, the growth rate of skill premium also depends on the cross-sector reallocation of factors. This is the H-O mechanism, whereby reductions in trade costs lead to shifts in factors of production towards the sectors where the country displays comparative advantages. This in turn raises the return of the factor that is used more intensively in those sectors.

4. Calibration

Most of the parameters specific to each Baltic economy (such as the input shares and total factor productivity scale parameters in the production functions, as well as the parameters in the agents' utility functions) can be directly calibrated from a social accounting matrix (SAM) by using the optimality and market clearing conditions and choosing physical units such that prices—including factor prices—are equal to one in the base case. Thus, a central step in the calibration exercise is the construction of a SAM for each Baltic state.[5] To build the matrices we work with data from the WIOD, using 1995 as the base year to coincide with the initial year of the period we analyze.

Sectoral aggregation As we mentioned in Section 3, our model features a Baltic economy with two sectors: goods and services. In Appendix 1 we describe how we assigned all the industries in the WIOD's input-output tables to the two sectors of our model. In Appendix 1 we also report the skill intensity of each sector, measured by the share of hours worked by skilled workers. Those data are taken from the WIOD's Socio Economic Accounts, which contain industry-level data on employment (including the number of workers and their educational attainments), capital stock, gross output and value added at current and constant prices. We find that, for all three countries, the average skill intensity in the services sector is approximately three times larger than the corresponding average in the goods sector. Consequently, in what follows we use the terms "goods sector" and "unskilled-labor intensive sector" interchangeably, as we do for the terms "services sector" and "skilled-labor intensive sector."

Households classification and expenditures disaggregation The WIOD allows us to build a SAM with a single aggregate household, but provides limited information on how to disaggregate households by skill type. To do so, we use Household Budget Surveys (HBS) from each Baltic state. These surveys contain data on households' expenditures, savings and income according to the level of educational attainment of the household head. This allows us to group households' expenditures on goods and services, as well as total income, in two categories: one for "high skilled"—or simply "skilled" workers, who are those with tertiary

[5] A SAM is a record of all the transactions that take place in an economy during a given period of time, typically one year. It provides a snapshot of the structure of production, where the row entries record the receipts of a particular agent and the column entries represent the payments made by the agents. Depending on the data availability, it can provide a much disaggregated level of institutional detail, with different types of firms, levels of government, households that differ in basic demographic characteristics and several trade partners.

education—and the other for "low skilled," or "unskilled" workers, who are those without.

Value added disaggregation The SEA data allow us to split each sector's aggregate labor compensation component of value added into skilled and unskilled labor compensation. However, the WIOD only contains the aggregate capital income component of value added, but it does not present a breakdown by different types of capital stock. To split this component into equipment and structures capital, we use data from the OECD National Accounts database (more details are provided in Section 5). Both types of capital income are distributed between skilled and unskilled households according to their respective average income ratios found in the HBS data.

The resulting SAMs we constructed for Estonia, Latvia and Lithuania for the year 1995 can be found in Appendix 2. With the SAMs in hand, we can proceed to calibrate the model's parameters. For example, dividing the first order condition for equipment capital by the one for skilled labor for the domestic component firm in sector i yields:

$$\frac{r_e}{w_s} = \frac{\mu_i k_{e,i}^{\rho-1}}{(1-\mu_i)\ell_{s,i}^{\rho-1}}$$

Using the first order conditions again, and setting $w_s = 1$ and $r_e = 1$ implies:

$$\frac{r_e k_{e,i}}{w_s \ell_{s,i}} = \left(\frac{\mu_i}{1-\mu_i}\right)^{\frac{1}{1-\rho}}$$

The numerator on the left-hand side is equipment capital income in sector i, and the denominator is skilled labor income in that sector. Those numbers can be found in the SAM. In the case of the unskilled intensive goods sector in Estonia in 1995, we have:

$$\frac{50.0}{131.1} = \left(\frac{\mu_G}{1-\mu_G}\right)^{\frac{1}{1-\rho}}$$

Setting $\rho = -0.5$ (below we explain in more detail the values we choose for the elasticities), gives us $\mu_G = 0.191$. All the calibrated parameters are shown in Appendix 3.

Labor/leisure data Next, since our model incorporates labor-leisure choice, we model each household as being endowed with a maximum number of available hours, assumed to be 5200 per year (100 hours per week $\times$ 52 weeks per year). We then multiply the total endowment of time per worker by the number of workers of type j.[6] The resulting value corresponds to $\bar{L}_j$ in the model. Moreover, the SEA include information on total hours worked in each sector, as well as the fraction of skilled and unskilled hours worked for each sector. Thus, we can back out the total hours devoted to leisure as the difference between the total time endowment and the total hours worked by each type of worker.

Parameter values taken from external sources Finally, some parameters in the model cannot be calibrated directly from the SAM or other external data. For those parameters, we assign commonly-used values from the literature. Those values are summarized in Table 4.1 and are the ones we use in our benchmark experiments.

Table 4.1. Parameters and Elasticity Values

Parameter	Value	Corresponding Elasticity	Implied Elasticity
$\rho_{m,i}$	0.827	Import elasticity of substitution	5.78
ρ_x	0.9	Export elasticity of substitution	10
ρ	-0.5	Equipment-skilled labor elasticity	0.67
σ	0.4	Equipment-unskilled labor elasticity	1.67
η	-1	Consumption goods elasticity of substitution	0.5
ψ	-0.25	Consumption-leisure elasticity of substitution	0.8

We set $\rho_{m,i}$, the parameter that governs the import elasticity of substitution in sector i, to take the value of 0.827. This is the average of 0.844, 0.758 and 0.879, the values estimated in Ruhl (2008), Simonovska and Waugh (2014), and Eaton and Kortum (2002), respectively. Our choice of $\rho_{m,i}$ implies an import elasticity of substitution of 5.78.[7] Similarly, the export elasticity of substitution ε_x is set at 10 (or $\rho_x = 0.9$), a value in the middle of the range of estimates for this parameter in the literature.

We follow Krusell et al. (2000) and assume that the elasticity of substitution between equipment capital (or skilled labor) and unskilled labor is higher than the elasticity of substitution between equipment and skilled labor. Thus, we set ρ, the parameter that governs the latter elasticity to -0.5, and σ, the parameter that determines the former, to 0.4. Having $\sigma > \rho$ reflects the capital-skill complementarity assumption.[8] In our case, the corresponding elasticities of substitution for equipment-skilled labor and equipment-unskilled labor are set

[6]Since the Socio Economic Accounts only provide the total number of workers, we determine the number of skilled and unskilled workers using the International Labor Organization (ILO) database on employment.

[7]Due to the lack of estimates of sectoral elasticities for the Baltic states, we use the same value for all sectors.

[8]When $\sigma = \rho \to 0$, yields a Cobb-Douglas production function with no complementarity between capital and skilled labor. We test the implications of that set of values in the sensitivity analysis.

at 0.67 and 1.67, respectively.

Finally, the parameter η determines the elasticity of substitution among the different consumption and investment goods in the households utility functions. Following Stockman and Tesar (1995), we set $\eta = -1$ so that the elasticity of substitution between consumption goods is equal to 0.5. Moreover, we follow Auerbach and Kotlikoff (1987) and choose $\psi = -0.25$, which yields an elasticity of substitution between consumption and leisure of 0.8, a value close to the estimate of Ghez and Becker (1975).[9]

5. Numerical Experiments and Benchmark Results

The calibrated model economies replicate the transactions recorded in the 1995 SAMs, which in our analysis represent the original equilibrium in each Baltic state. We next subject each economy to a series of shocks that incorporate the stylized facts documented in Section 2. This allows us to answer two questions: how would the different labor markets—and more specifically, the skill premium—in our model react if these shocks were implemented individually? And what if they all were to operate simultaneously? Before going over the results, we describe the nature of the experiments we conduct in more detail. The exact values we use for the shocks we introduce are reported in Table A5.1 in Appendix 5.

Changes in the terms of trade (ToT) experiment. In Section 2 we documented that, even though the Baltics are all quite open economies, the terms of trade that these countries experienced took divergent paths. In the goods sector, both Estonia and Lithuania experienced an improvement (or increase) in the terms of trade between 1995 and 2008, while the opposite took place in Latvia, where the terms of trade deteriorated during the same period. We explore whether these diverging patterns in the terms terms of trade can account for the divergence of skill premium. To do so, in this experiment we allow the prices of the foreign components used in final production ($\bar{p}_{f,i}$, which as small economies the Baltics take as exogenous) to vary so that, coupled with all other prices at their baseline levels, they result in the terms of trade changing by the same proportion as reported in the European Commission's AMECO database.

Equipment capital deepening experiment. Measures of capital stock decomposed by type are not readily available for the Baltics. However, the OECD National Accounts database

[9] Auerbach and Kotlikoff (1987) run a robustness check with $\psi = -1.5$, which implies a lower elasticity of substitution of 0.4. We try that case in the sensitivity analyses section, as well as the case of $\psi \to 0$, which yields a unit elasticity utility function.

presents Gross Fixed Capital Formation series disaggregated by type of capital for all three Baltic states. This allows us to construct structures and equipment capital stock series[10] using the perpetual inventory method, according to which capital follows the law of motion:

$$K_{i,t+1}^n = (1 - \delta_i^n)K_{i,t}^n + I_{i,t}^n \tag{10}$$

where $K_{i,t}^n$ is stock of capital of type i in period t in country n; and δ_i^n and $I_{i,t}^n$ are the depreciation rate and investment in the corresponding type of capital and country in period t. To compute the initial level of each type of capital stock in each country—in our case, 1995—we follow Hall and Jones (1999) and Caselli (2005) and set $K_{i,1995}^n = I_{i,1995}^n/(g_i^n + \delta_i^n)$, where g_i^n is the average growth rate of investment of type-i capital in country n.

After calculating the capital growth series, the equipment capital deepening experiment consists in increasing the total stock of capital equipment $\bar{K}_e$ and capital structures $\bar{K}_z$ to match those observed in the data. Note that in this simulation we increase *both* types of capital but, as the literature has previously established, what really is complementary to skilled labor is equipment capital and not necessarily the total stock of capital. That is why we refer to this experiment as "equipment capital deepening," since we expect the changes in the skill premium to be driven mostly by changes in equipment capital. Since the growth rates of equipment capital vary substantially across the Baltic states, we expect countries that experienced higher growth rates of equipment capital expansion to also display higher increases in skilled labor demand, and in turn larger increases in the skill premium.

Changes in the relative skill composition of labor supply experiment. As mentioned earlier, all three Baltic states experienced similar demographic trends: shrinking populations coupled with increases in the number of college graduates. Using the data in Barro and Lee (2013), we first calculate series for the total number of skilled and unskilled workers between 1995 and 2008. Those series allow us to compute the changes in the relative skill composition of labor supply for each country. We find that although the trends are similar in qualitative terms, the specific growth rates are quite uneven: between 1995-2008, Lithuania led the group with a 91% increase in the population with tertiary education (which corresponds to our definition of skilled workers) aged 15 years or older, compared to increases in Estonia and Latvia of 53% and 31%, respectively. Similarly, although all three countries experienced a reduction in their unskilled population, the changes vary significantly across the Baltics:

[10] We group "transport equipment," "ICT equipment" and "other machinery and equipment and weapon system" into a category we call "equipment capital," and "dwellings" and "other building structures" into a category we label as "structure capital."

Estonia exhibits the largest decrease in its unskilled population with a 15.3% decline, compared to the 12.7% and 5.8% decreases in Lithuania and Latvia, respectively. Thus, Latvia exhibits the smallest increase in skilled population and the smallest decrease in unskilled population among the Baltic states. In these numerical experiments, we use these trends in labor supply composition to re-calibrate the values of $\bar{L}_u$ and $\bar{L}_s$, the total available number of unskilled and skilled hours, and examine how the increases in skilled labor supply and decreases in unskilled labor supply observed in the data affect labor markets and the skill premium.

5.1. Benchmark Results

5.1.1. Effects of the changes in the terms of trade

As noted earlier, the Baltic states experienced divergent terms of trade changes. Estonia and Lithuania recorded improvements in terms of trade across all sectors, with the skilled-labor intensive services sector benefiting more than the unskilled-labor intensive goods sectors. On the other hand, the Latvian terms of trade in the goods sector worsened, while they improved for the services sector (which has a smaller weight on overall trade volume).

Table 5.1: Benchmark Results: Effects of Changes in the Terms of Trade
(percent change)

Variable	Type/Sector	Estonia	Latvia	Lithuania
Skill premium		-2.2	-1.9	-1.3
Wage	Skilled labor	10.8	-4.0	20.2
	Unskilled labor	13.3	-2.1	21.7
Imports	Unskilled sector	88.5	-39.1	274.3
	Skilled sector	333.8	56.4	621.6
Exports	Unskilled sector	116.6	-33.5	319.9
	Skilled sector	63.5	0.7	16.5
Final output	Unskilled sector	34.9	-6.4	89.4
	Skilled sector	6.0	-1.1	4.6
Domestic output	Unskilled sector	9.4	7.4	5.0
	Skilled sector	-4.8	-2.8	-3.8
Unskilled labor demand	Unskilled sector	7.6	6.7	3.0
	Skilled sector	-7.3	-4.1	-6.1
Skilled labor demand	Unskilled sector	11.5	9.2	5.7
	Skilled sector	-3.9	-1.5	-3.8

As shown in Table 5.1, as a response to changes in the terms of trade as observed in the data, our model generates trade increases —both exports and imports— in both sectors for

Estonia and Lithuania, while in Latvia trade declines in the goods sector and increases in the services sector. These trade changes translate into final production changes in all three countries, with final output increasing in Estonia and Lithuania, and decreasing in Latvia. With output rising, wages go up in the former two countries, while they fall in the latter.

As for the effects on the skill premium, all three countries uniformly experience a small decrease in their skill premium, with the largest decline taking place in Estonia (2.2%) and the smallest one in Lithuania (1.3%). This declining pattern in the skill premium is due to larger increases in unskilled wages than in skilled wages for Estonia and Lithuania, whereas in Latvia is the result of a larger decrease in skilled wages than in unskilled wages.

To understand why both positive and negative trade shocks lead to the same qualitative effect on the skill premium in all three countries, we examine the patterns of sectoral reallocation of resources by looking at the changes in domestic production and demand for both types of labor in each sector. For Estonia and Lithuania, labor shifts from the skilled-labor intensive services sector toward the unskilled-labor intensive goods sector. In turn, domestic production of goods increases. This is the H-O mechanism in action, where as a response to a positive trade shock countries shift their resources to increase exports in the sectors in which they enjoy comparative advantages.[11] In Latvia, on the other hand, labor shifted to increase the production of the domestic component in the goods sector, to substitute the imported component which had become more expensive as a result of the negative trade shock in that sector.

5.1.2. Effects of equipment capital deepening

The largest increase in equipment capital between 1995 and 2008 among the Baltics took place in Latvia, where it rose by nearly a factor of 8. On the other hand, the expansions in equipment capital in Estonia and Lithuania were of relatively smaller magnitude. Indeed, when we feed the observed increases in both types of capital, our model generates the largest increase in the skilled relative wage for Latvia, where it goes up by 49.3%, followed by Lithuania and Estonia, where the skill premium increased by 28.9% and 27.0%, respectively. The effect of changes in the stock of capital equipment is shown in Table 5.2 below.

[11] The data suggest that the Baltic states have comparative advantages in sectors that are unskilled-intensive. For example, during the 1995-2008 period, sectors such as wood products, textiles, foodstuffs, and animal products display values for the Revealed Comparative Advantage (RCA) index that are well in excess of unity, while skill-intensive sectors such as machinery and electrical equipment and transport equipment exhibit RCA values below 1.

Table 5.2: Benchmark Results: Effects of Changes in Equipment Capital
(percent change)

Variable	Type/Sector	Estonia	Latvia	Lithuania
Skill premium		27.0	49.3	28.9
Wage	Skilled labor	82.9	175.8	114.2
	Unskilled labor	44.0	84.8	66.2
Rental price	Equipment capital	-85.7	-88.1	-88.3
Final output	Unskilled sector	42.3	83.2	60.7
	Skilled sector	51.5	97.3	68.7
Domestic output	Unskilled sector	49.9	96.9	74.7
	Skilled sector	52.8	99.1	69.3
Equipment capital demand	Unskilled sector	494.9	1064.5	799.4
	Skilled sector	409.3	671.7	544.9
Unskilled labor demand	Unskilled sector	-3.1	-10.5	-10.8
	Skilled sector	-1.7	-6.4	-4.0
Skilled labor demand	Unskilled sector	8.9	42.9	29.3
	Skilled sector	-6.7	-5.3	-7.3

To disentangle the forces driving these changes in the skill premium, we analyze the changes in the relevant variables reported in Table 5.2. First, the increases in the stock of capital drive down the rental prices of capital which in turn raise the demand for capital in all sectors. Second, with larger stocks of capital, both domestic and final output increase in all sectors. Third, capital deepening—and more specifically, *equipment* capital deepening—affects the demands of the two types of labor differently, favoring skilled over unskilled labor. As implied by equation (9), the skill premium rises for all three countries and we find that this is due to the wage of skilled labor rising faster than that of unskilled labor. Finally, capital deepening and the resulting changes in the relative wages generate reallocation of labor both across and within sectors. For example, in the services sector both types of labor demand fall. On the other hand, in the goods sector the demand for the skilled labor rises while the demand of unskilled labor declines.

5.1.3. Effects of changes in the skill composition of labor supply

Table 5.3 shows the effects of the labor supply shock. First, despite mixed effects in the hours worked by different skill types, total hours worked rise for all three countries. Therefore, skill composition changes—or "skill-upgrading" of labor force—lead to increases in final production in all sectors, as well as in aggregate domestic production. Despite this positive impact on aggregate output, we observe differentiated effects on the factors of production. As unskilled labor become scarcer, its wage rises. The opposite occurs for skilled labor. This effectively lowers the skill premium in all three countries. Finally, the changes in the relative wages are translated in increases in the demand for skilled workers and decreases in the demand for unskilled workers across all sectors.

Table 5.3: Benchmark Results: Effect of Changes in Skill Composition of Labor Supply
(percent change)

Variable	Type/Sector	Estonia	Latvia	Lithuania
Skill premium		-41.5	-28.2	-53.6
Wage	Skilled labor	-30.1	-23.2	-45.1
	Unskilled labor	19.5	7.1	18.3
Final output	Unskilled sector	2.9	0.1	4.1
	Skilled sector	9.0	4.3	11.7
Domestic output	Unskilled sector	1.4	-1.1	2.6
	Skilled sector	9.6	4.6	12.1
	All sectors	6.9	2.9	8.9
Hours worked	Unskilled labor	-21.8	-4.7	-8.5
	Skilled labor	58.7	29.4	84.4
	Total labor	16.7	4.4	30.6
Unskilled labor demand	Unskilled sector	-16.8	-6.8	-12.6
	Skilled sector	-25.5	-11.2	-27.3
Skilled labor demand	Unskilled sector	64.8	30.5	100.9
	Skilled sector	57.4	34.1	105.5

5.1.4. Joint simulation results

Summarizing, the individual experiments yield the following results: the terms of trade shocks lowered the skill premium across the Baltics, with Estonia experiencing the largest decline and Lithuania the smallest one. Equipment capital deepening increased the skill premium, with Latvia recording the largest surge and Estonia and Lithuania relatively smaller but comparable increases. Finally, the changes in the skill composition of labor supply lead to sizable decreases in the skill premium across the three countries, with the lowest fall in Latvia and larger and similarly-sized drops in Estonia and Lithuania.

The joint simulation incorporates all three shocks simultaneously. The corresponding results are presented in Table 5.4. Including all three shocks generates skill premium decreases in Estonia and Lithuania of -22.4% and -35.3% respectively, which qualitatively —and quantitatively for the case of Estonia— match the changes observed in the data. For the case of Latvia, our model predicts an increase in the skill premium of 9.8%, closely replicating the observed growth in Latvian relative wages. The joint experiment allows us to assess the relative magnitudes of labor demand and labor supply shocks: in Latvia, the demand shocks dominates the supply one, whereas in Estonia and Lithuania the supply shock dominates the demand effects.

Table 5.4: Benchmark Results: Joint Simulation
(percent change)

Variable	Estonia	Latvia	Lithuania
Skill premium (data)	-20.2	16.3	-13.1
Skill premium (model)	-22.4	9.8	-35.3
Skilled wage	50.1	117.1	52.7
Unskilled wage	93.4	97.6	136.0

6. Sensitivity Analyses

6.1. Skill Premium Patterns at Intermediate Horizons

Our model can account well for the changes in the skill premium over the 1995-2008 period. The next natural question is whether it can also account for the skill premium patterns within that time span since in the data the evolution of the skill premium is non-monotonic. More precisely, the skill premium initially increased in all three countries between 1995 and 2000, and declined subsequently. Therefore, to better examine the accuracy of our model, we re-run the experiments for shorter time horizons and determine whether the skill premium changes generated by the model also display the kind of non-monotonic behavior observed prior to and after 2000. To do so, we first simulate the changes in all three shocks between 1995 and 2000. Next, we construct SAMs for the three countries using the year 2000 as the base year, and simulate the changes in the shocks that occurred between 2000 and 2008. The SAMs for the year 2000 are shown in Appendix 4, and the shocks for the two sub-periods are shown in Tables A5.2 and A5.3 in Appendix 5.

Table 6.1: Skill Premium Patterns 1995–2000 and 2000–2008
(percent change)

	1995-2000			2000-2008		
Experiment	Estonia	Latvia	Lithuania	Estonia	Latvia	Lithuania
Data	*4.3*	*20.7*	*5.3*	*-24.4*	*-4.4*	*-18.4*
Joint	-18.0	31.3	3.5	1.4	-8.6	-34.4
ToT	-1.0	-2.6	-0.7	-0.5	0.5	0.5
Capital deepening	12.0	22.7	14.4	26.8	39.5	23.9
Skill supply	-27.1	10.1	-9.5	-21.2	37.0	-49.9

As reported in Table 6.1, our model is able to reproduce the initial rise and the subsequent fall of the skill premium observed during the two sub-periods for the Latvian and Lithuanian cases. For Latvia, the model generates a large increase in the skill premium between 1995 and

2000, as both capital deepening and skill supply changes lead to rises in the skill premium. In fact, Latvia experienced a sizable decrease in the skilled working-age population during this period, which accounts for the rising skill premium. For the 2000-2008 period, the model yields a small decline in the skill premium, since the effects of capital deepening and skill supply changes offset each other. On the other hand, the model generates a small increase in the Lithuanian skill premium for the first sub-period, as the effect of capital deepening slightly dominates that of skill supply changes. For the period between 2000 and 2008, the changes in skill supply play a dominant role in the model in driving down the skill premium.

While the movements in the skill premium that our model generates are in line with those observed in the data for Latvia and Lithuania, we cannot quite capture the timing of the skill premium patterns for the Estonian case. In the data, the skill premium in Estonia increases slightly between 1995 and 2000, while our model predicts a large fall in the relative skilled wage since the labor supply effect dominates the labor demand ones. Moreover, the significant decrease in the Estonian skill premium observed after 2000 cannot be matched by our simulations. Since our model only considers the contemporaneous effects of labor supply and demand factors, we are unable to explain why the labor supply factors have this lagged effect on the skill premium in Estonia. This might be due to country-specific factors that are not explicitly included in our model. For example, as documented in Toomet (2011), there is a large fraction —almost one third— of ethnic Russians in Estonia that, although similar in terms of human capital levels as the local population, significantly lags behind in terms of their income growth. In the presence of such pervasive discrimination in the labor market—which our model does not contemplate—we could certainly expect large increases in the supply of skilled workers to decrease the skill premium in a longer horizon, though not immediately.

6.2. The Role of Trade Elasticities

We now explore whether our findings depend on the choice of the trade elasticities. Kehoe and Ruhl (2008) show that as the Armington elasticity of substitution increases, changes in the terms of trade have larger effects on real output. Our results concur with their findings, as higher elasticities of import substitution lead to reallocation of resources across sectors of larger magnitudes and, in turn, larger changes in the skill premium. Table 6.2 shows the results of the numerical experiments when we re-run the simulations using alternative values for ρ_m. The values we use, 0.758, 0.844 and 0.879, are frequently cited in the literature, and are taken from Simonovska and Waugh (2014), Ruhl (2008), and Eaton and Kortum (2002), respectively (our benchmark value of 0.827 is the simple average of those three values).

We find that varying the elasticity of substitution has little impact on skill premium changes in the joint simulation, but has more significant implications under the terms of trade experiment. The values of ρ_m we use imply import elasticities that range from 4.13 to 8.26. That 100% increase in the import elasticity is associated with additional decreases in the skill premium in the ToT experiment of approximately 2 percentage points in Estonia (-1.5% to -3.6%), 2.2 percentage points in Latvia (-1.0% to -3.2%), and 0.8 percentage points in Lithuania (-1.1% to -1.8%). The fact that higher import elasticities are associated with larger changes in the skill premium highlights the Heckscher-Ohlin mechanism that predicts that changes in the trade volumes lead to larger shifts towards the unskilled sectors, where these countries enjoy comparative advantages.

Table 6.2: Sensitivity Analysis: Changes in the Import Elasticity Parameter (ρ_m)
(percent change)

		Change in Skill Premium			
			(Benchmark)		
Country	Experiment	$\rho_m = 0.758$	$\rho_m = 0.827$	$\rho_m = 0.844$	$\rho_m = 0.879$
Estonia	Joint	-22.3	-22.4	-22.5	-22.9
	ToT	-1.5	-2.2	-2.5	-3.6
Latvia	Joint	10.7	9.8	9.6	8.8
	ToT	-1.0	-1.9	-2.3	-3.2
Lithuania	Joint	-35.5	-35.3	-35.3	-35.2
	ToT	-1.1	-1.3	-1.4	-1.8

Next, we run a similar robustness check for the export elasticity of substitution. We use two alternative values: one where the value of ρ_x is equal to 0.827 (a value identical to our benchmark figure for ρ_m), and another where the value of ρ_x is equal to 0.9135, which translates into an export elasticity which is twice as large as the one implied by our previous choice of $\rho_x = 0.827$. The corresponding results are presented in Table 6.3.

As in the previous case, changing ρ_x only affects the ToT experiment results and has negligible effects on the skill premium under the joint experiment. The values of ρ_x used in this robustness check imply elasticities that range from 5.78 to 11.56. In the ToT experiment, the 100% increase in the export elasticity is associated with larger decreases in the skill premium of around 0.9 percentage points in Estonia, and smaller declines in the skill premium in Latvia. In Lithuania, on the other hand, export elasticity increases switch the direction of the skill premium changes from increasing to decreasing. In addition, the relative magnitude of skill premium changes is the largest in the Lithuanian case, at 2.8 percentage points (going from a 0.6% increase to a 2.2% decrease).

Table 6.3: Sensitivity Analysis: Changes in the Export Elasticity Parameter (ρ_x)
(percent change)

		Change in Skill Premium		
			(Benchmark)	
Country	Experiment	$\rho_x = 0.827$	$\rho_x = 0.9$	$\rho_x = 0.9135$
Estonia	Joint	-22.7	-22.4	-22.4
	ToT	-1.6	-2.2	-2.5
Latvia	Joint	9.1	9.8	10.1
	ToT	-2.3	-1.9	-1.8
Lithuania	Joint	-35.0	-35.3	-35.6
	ToT	0.6	-1.3	-2.2

6.3. The Role of Capital-Skill Complementarity

In the benchmark experiments, we used the values of ρ and σ reported in Krusell et al. (2000). As those values implied a higher elasticity of substitution between equipment capital and unskilled labor than between equipment capital and skilled labor, capital-skill complementarity was embedded in the model. Here, we assess the robustness of our results to the assumption of capital-skill complementarity in production. We conduct our simulation with two alternative specifications: the first one, with $\rho = \sigma = 0$, implies a Cobb-Douglas production function, where the elasticities between equipment capital and the two types of labor are equal to one. In the second specification, we strengthen the degree of capital-skill complementarity by using the average of the parameter values found in Polgreen and Silos (2008) (which in turn is a sensitivity analysis of the exercise conducted in Krusell et al., 2000). The averages yield values of $\rho = -0.357$ and $\sigma = 0.659$.

The results of this sensitivity analysis are depicted in Table 6.4, where we also present our benchmark findings. We find that the term $(\sigma - \rho)$ in equation (9) effectively gauges the degree of capital-skill complementarity and how the growth of capital equipment affects the skill premium. Under the Cobb-Douglas specification, since $\rho = \sigma$, the first term in the equation (9) cancels and the skill premium only depends on the relative growth rates skilled and unskilled labor supply. Consequently, increases in capital equipment play no role in the evolution of skill premium, and the absence of capital-skill complementarity results in large decreases in the skill premium under the joint experiment for all three countries. In addition, since σ governs the elasticity of substitution between equipment capital and unskilled labor, larger the values of σ (implying larger elasticities), lead to smaller effects of relative skill supplies on skill premium. Finally, incorporating the stronger degree of capital-skill complementarity implied by the values in Polgreen and Silos (2008), results in the joint experiment still showing the diverging skill premium patterns across the Baltics, in line with our qualitative findings under the benchmark parameters.

Table 6.4: Sensitivity Analysis: Changes in the Technology Parameters
(percent change)

Country	Experiment	Change in Skill Premium (Cobb-Douglas) $\rho = 0$ $\sigma = 0$	(Benchmark) $\rho = -0.5$ $\sigma = 0.4$	(Polgreen-Silos) $\rho = -0.357$ $\sigma = 0.659$
Estonia	Joint	-49.6	-22.4	-4.8
	ToT	-3.3	-2.2	-1.3
	Capital deepening	-0.8	27.0	33.2
	Skill supply	-48.7	-41.5	-31.1
Latvia	Joint	-34.5	9.8	37.2
	ToT	-2.4	-1.9	-1.4
	Capital deepening	-1.7	49.3	71.7
	Skill supply	-31.3	-28.2	-22.5
Lithuania	Joint	-59.4	-35.3	-15.4
	ToT	-2.1	-1.3	-0.7
	Capital deepening	-0.4	28.9	39.5
	Skill supply	-59.4	-53.6	-43.6

6.4. The Role of Preferences for Consumption, Labor and Leisure

Our last set of sensitivity experiments focuses on the role of the preference parameters. First, in the benchmark simulations the parameter η, which determines the elasticity of substitution between the different consumption goods (including the investment good), was set to -1. This implied the elasticity of substitution among goods to be 0.5. As shown in the first column of Table 6.5, changing this parameter to the value of 0—implying a logarithmic utility function—does not lead to any noticeable differences in the changes of the skill premium when compared to our benchmark results, for both the individual and the joint experiments.

Next, we examine the effects of varying the degree of elasticity between aggregate consumption and leisure, which is governed by the value of ψ. We test two alternative values of ψ: one where $\psi = 0$, which yields a Cobb-Douglas utility function, The other with $\psi = -1.5$, where the elasticity of substitution between consumption and leisure is 0.4, or exactly half the value we use in the benchmark simulations. We find that the lower the elasticity between consumption and leisure, the larger the changes in the skill premium, especially under the capital deepening and relative skill supply experiments. For example, with a 50% reduction in the elasticity, the additional increases in skill premium under the capital deepening experiment range between 8.8 percentage points in Estonia to 18.2 percentage points in Latvia. The fact that changes in the labor-leisure margin also affect the capital deepening experiment is due to different degree of substitution between capital and the two types of labor.

As for the relative skill supply changes, additional decreases in the skill premium range from 6.9 percentage points in Latvia to as high as 9.8 percentage points in Lithuania.

Finally, in the last column of Table 6.5 we set $\zeta_j = 1$. This is the case where leisure does not enter the utility function and labor is inelastically supplied. When the labor-leisure decision is no longer endogenously determined, the qualitative implications for the joint experiment remain unchanged. However we note that, for all three countries, the magnitudes of the decreases in the skill premium in the relative skill supply experiment are smaller than in the benchmark simulation. As a result, in the joint experiment the magnitude of the decrease in skill premium is smaller in Estonia and Lithuania, while the skill premium increase is larger in Latvia.

Table 6.5: Sensitivity Analysis: Changes in the Preference Parameters
(percent change)

		Change in Skill Premium				
		(Log utility)	*(Benchmark)*	*(Cobb-Douglas)*		*(Inel. labor)*
Country	Experiment	$\eta = 0$	$\eta = -1$	$\eta = -1$	$\eta = -1$	
		$\psi = -0.25$	$\psi = -0.25$	$\psi = 0$	$\psi = -1.5$	$\zeta_j = 1$
Estonia	Joint	-22.4	-22.4	-21.0	-26.3	-17.9
	ToT	-2.2	-2.2	-2.2	-2.1	-2.5
	Capital Deepening	27.0	27.0	24.1	35.8	25.0
	Skill Supply	-41.5	-41.5	-38.5	-49.0	-36.4
Latvia	Joint	10.0	9.8	9.0	13.1	22.4
	ToT	-1.8	-1.9	-1.7	-2.6	-2.3
	Capital Deepening	49.3	49.3	44.2	67.5	59.2
	Skill Supply	-28.2	-28.2	-25.7	-35.1	-25.3
Lithuania	Joint	-35.4	-35.3	-32.7	-42.8	-24.2
	ToT	-1.5	-1.3	-1.4	-0.6	-1.9
	Capital Deepening	28.9	28.9	25.3	40.8	32.8
	Skill Supply	-53.6	-53.6	-49.5	-63.4	-47.4

7. Conclusion

We propose a static general equilibrium model to account for the evolution of the skill premium. Our model incorporates forces that have a biased effect on the demand for skilled and unskilled labor: international trade, which we model in the form of terms of trade changes, and capital-skill complementarity, which we model as expansions in the stock of equipment capital. Unlike the large majority of recent articles in the literature, our model also incorporate factors that affect the supply of labor, which we model as changes in the relative skill composition of the labor supply due to demographic changes.

To assess the quantitative validity of the model's predictions, we apply it to account for the patterns of the skill premium in the Baltic states—Estonia, Latvia and Lithuania. Despite initial similarities, the skill premium in these countries evolved in diverging patterns—between 1995 and 2008, the skill premium in Latvia increased by 16%, whereas in Estonia and Lithuania it declined by 20% and 13%, respectively.

A calibrated version of our model proves our approach to incorporate both labor supply and labor demand factors to be accurate. Indeed, the numerical experiments we conduct suggest that both forces played equally important roles in determining the paths of the skill premium in the Baltics. Specifically, increases in the relative skill supply lead to declines in the skill premium, whereas equipment capital deepening generated skill premium increases. Moreover, terms of trade changes lead to the reallocation of resources toward the sectors in which the Baltic states have comparative advantages, and this in turn lowered the skill premium. Simulating all three shocks simultaneously predicts changes in the skill premium that are in line with the Baltic divergence: declines in the Estonian and Lithuanian skill premium of 22% and 35% respectively, and an increase in the Latvian skill premium of 10%.

Our results display robustness to the choices of trade and preference elasticities of substitution. The sensitivity exercises also highlight the importance of the capital-skill complementarity mechanism in accounting for skill premium changes. Moreover, when we run numerical simulations of our model over shorter periods of time to account for the non-monotonic behavior of the skill premium before and after the year 2000, we are able to capture the initial rise and subsequent fall of the skill premium in Latvia and Lithuania, although not for Estonia. We conjecture that this could be due to institutional features in the labor markets that have in some instances non-negligible effects on the skill premium. Assessing the role of such country-specific factors is beyond the scope of this article, but would suitably complement the finding of our analysis.

Appendix 1: Sectoral Aggregation and Skill Intensities in 1995

		Share of Hours by Skilled Workers		
2-Sector SAM	ISIC Rev. 3 Sectors	Estonia	Latvia	Lithuania
Goods (Unskilled)	Agriculture (A-B)	10.7%	4.4%	4.1%
	Mining (C)	16.1%	12.6%	18.0%
	All manufacturing (D)	20.6%	13.2%	15.6%
	Average	15.8%	10.1%	12.6%
Services (Skilled)	Electricity and gas service (E)	18.4%	16.0%	15.7%
	Construction (F)	24.3%	21.4%	17.8%
	Wholesale and retail service (G)	41.5%	26.3%	34.7%
	Hotel and restaurants (H)	27.9%	10.3%	33.8%
	Transport and communication (I)	34.7%	25.6%	28.1%
	Financial service (J)	67.0%	56.7%	52.9%
	Real estate and business service (K)	45.7%	45.8%	55.5%
	Public service (L)	42.1%	32.4%	43.5%
	Education (M)	71.9%	63.9%	70.0%
	Health (N)	55.7%	34.0%	42.7%
	Social and personal service (O)	40.4%	20.0%	29.5%
	Average	42.7%	32.0%	38.6%

Appendix 2: Social Accounting Matrices (1995)

SAM Estonia 1995 **(Unit: Euro, Millions)**

	Goods	Service	L	K (equipment)	K (structure)	C	C (Unskilled)	C (Skilled)	I	G	X	Total
Goods	1544.9	948.5	0.0	0.0	0.0	1109.8	734.2	375.6	443.3	24.9	1199.0	5270.3
Service	981.8	4495.3	0.0	0.0	0.0	541.1	342.4	198.7	336.7	676.3	466.4	7497.5
Labor	483.0	1100.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1583.6
(Unskilled)	351.9	473.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	825.0
(Skilled)	131.1	627.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	758.6
Capital equipment	50.0	147.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	197.1
(Unskilled)	41.4	121.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	163.1
(Skilled)	8.6	25.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0
Capital structure	166.4	489.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	656.2
(Unskilled)	137.7	405.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	543.0
(Skilled)	28.7	84.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.2
Households	0.0	0.0	1583.6	197.1	656.2	0.0	0.0	0.0	0.0	0.0	0.0	2437.0
Government	291.6	37.8	0.0	0.0	0.0	402.1	252.6	149.5	0.0	0.0	0.0	731.4
Direct Tax	0.0	0.0	0.0	0.0	0.0	402.1	252.6	149.5	0.0	0.0	0.0	402.1
Indirect Tax	291.2	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	329.0
Tariff	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Leisure	0.0	0.0	0.0	0.0	0.0	2623.1	1423.1	1200.0	0.0	0.0	0.0	2623.1
Capital (Saving)	0.0	0.0	0.0	0.0	0.0	384.0	201.9	182.1	0.0	30.3	365.7	780.0
Import	1752.7	278.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2031.1
Total	5270.3	7497.5	1583.6	197.1	656.2	5060.1	2954.2	2105.8	780.0	731.4	2031.1	0.0

SAM Latvia 1995 **(Unit: Lats, Millions)**

	Goods	Service	L	K (equipment)	K (structure)	C	C (Unskilled)	C (Skilled)	I	G	X	Total
Goods	937.6	574.1	0.0	0.0	0.0	1026.3	610.5	415.8	210.9	10.9	689.5	3449.3
Service	591.0	3847.5	0.0	0.0	0.0	615.5	330.8	284.6	181.7	629.1	396.0	6260.7
Labor	420.1	863.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1283.3
(Unskilled)	349.2	449.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	799.1
(Skilled)	70.9	413.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	484.2
Capital equipment	66.8	187.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	254.1
(Unskilled)	34.5	96.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	131.2
(Skilled)	32.3	90.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	122.9
Capital structure	200.5	561.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	762.4
(Unskilled)	103.5	290.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	393.5
(Skilled)	97.0	271.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	368.8
Households	0.0	0.0	1283.3	254.1	762.4	0.0	0.0	0.0	0.0	0.0	0.0	2299.8
Government	275.9	39.5	0.0	0.0	0.0	324.6	187.3	137.3	0.0	0.0	0.0	640.0
Bond	0.0	0.0	0.0	0.0	0.0	41.7	24.4	17.3	0.0	0.0	0.0	41.7
Direct Tax	0.0	0.0	0.0	0.0	0.0	282.9	162.9	120.0	0.0	0.0	0.0	282.9
Indirect Tax	239.4	39.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	278.9
Tariff	36.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.5
Leisure	0.0	0.0	0.0	0.0	0.0	2861.2	2092.0	769.2	0.0	0.0	0.0	2861.2
Capital (Saving)	0.0	0.0	0.0	0.0	0.0	333.4	195.2	138.2	0.0	0.0	59.2	392.6
Import	957.5	187.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1144.7
Total	3449.3	6260.7	1283.3	254.1	762.4	5161.0	3415.9	1745.1	392.6	640.0	1144.7	0.0

SAM Lithuania 1995 **(Unit: Litas, Millions)**

	Goods	Service	L	K (equipment)	K (structure)	C	C (Unskilled)	C (Skilled)	I	G	X	Total
Goods	12211.9	6624.6	0.0	0.0	0.0	12249.5	8421.3	3828.2	2585.5	388.6	11299.3	45359.3
Service	8387.6	36246.7	0.0	0.0	0.0	4826.6	2928.3	1898.3	3511.0	6204.4	1908.3	61084.7
Labor	3642.7	8076.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11719.2
(Unskilled)	2922.8	3913.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6835.8
(Skilled)	720.0	4163.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4883.4
Capital equipment	431.6	1011.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1443.5
(Unskilled)	307.1	720.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1027.2
(Skilled)	124.5	291.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	416.3
Capital structure	3257.4	7636.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10893.7
(Unskilled)	2318.0	5434.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7752.0
(Skilled)	939.4	2202.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3141.8
Households	0.0	0.0	11719.2	1443.5	10893.7	0.0	0.0	0.0	0.0	0.0	0.0	24056.4
Government	2394.7	466.6	0.0	0.0	0.0	3731.7	2392.8	1338.9	0.0	0.0	0.0	6593.0
Bond	0.0	0.0	0.0	0.0	0.0	404.7	233.3	171.4	0.0	0.0	0.0	404.7
Direct Tax	0.0	0.0	0.0	0.0	0.0	3327.0	2159.6	1167.4	0.0	0.0	0.0	3327.0
Indirect Tax	2098.9	466.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2565.5
Tariff	295.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	295.8
Leisure	0.0	0.0	0.0	0.0	0.0	23527.6	13610.4	9917.2	0.0	0.0	0.0	23527.6
Capital (Saving)	0.0	0.0	0.0	0.0	0.0	3248.6	1872.5	1376.1	0.0	0.0	2847.9	6096.5
Import	15033.3	1022.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16055.5
Total	45359.3	61084.7	11719.2	1443.5	10893.7	47584.0	29225.4	18358.7	6096.5	6593.0	16055.5	0.0

Appendix 3: Calibrated Parameters (1995)

Table A3.1 Preferences Parameters: Skilled (θ^s), Unskilled (θ^u) and Government (θ^g)

	Estonia			Latvia			Lithuania		
	Skilled	Unskilled	Govt.	Skilled	Unskilled	Govt.	Skilled	Unskilled	Govt.
Goods	0.660	0.773	0.034	0.633	0.716	0.017	0.726	0.854	0.059
Services	0.185	0.168	0.925	0.297	0.210	0.983	0.179	0.103	0.941
Investment good	0.155	0.059	0.041	0.070	0.073		0.094	0.042	
Govt. bond				0.001	0.001		0.001	0.001	
Leisure $(1-\zeta)$	0.695	0.596		0.528	0.726		0.652	0.552	

Table A3.2 Domestic Goods Firm Parameters

	Estonia				Latvia				Lithuania			
	α	β	μ	λ	α	β	μ	λ	α	β	μ	λ
Goods	0.238	17.220	0.191	0.455	0.292	12.422	0.478	0.430	0.444	13.330	0.317	0.426
Services	0.282	14.608	0.102	0.614	0.349	14.010	0.234	0.601	0.457	11.844	0.107	0.584

Table A3.3 Final Goods Firm Parameters

	Estonia		Latvia		Lithuania	
	ϕ	δ	ϕ	δ	ϕ	δ
Goods	1.980	0.530	2.001	0.531	1.999	0.525
Services	1.711	0.637	1.685	0.646	1.620	0.669

Appendix 4: Social Accounting Matrices (2000)

SAM Estonia 2000 (Unit: Euro, Millions)

	Goods	Service	L	K (equipment)	K (structure)	C	C (Unskilled)	C (Skilled)	I	G	X	Total
Goods	3323.0	1921.0	0.0	0.0	0.0	2134.3	1412.0	722.3	941.5	39.3	3619.0	11978.1
Service	2149.5	11290.4	0.0	0.0	0.0	1626.4	1029.1	597.3	807.2	1177.5	1067.7	18118.7
Labor	815.6	2292.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3107.6
(Unskilled)	584.5	1118.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1702.8
(Skilled)	231.1	1173.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1404.9
Capital equipment	132.8	522.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	655.3
(Unskilled)	97.3	382.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	479.9
(Skilled)	35.5	139.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	175.4
Capital structure	353.1	1389.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1742.1
(Unskilled)	258.6	1017.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1275.9
(Skilled)	94.5	371.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	466.2
Households	0.0	0.0	3107.6	655.3	1742.1	0.0	0.0	0.0	0.0	0.0	0.0	5505.0
Government	567.0	87.8	0.0	0.0	0.0	561.9	352.2	209.7	0.0	0.0	0.0	1216.7
Bond	0.0	0.0	0.0	0.0	0.0	12.3	6.9	5.4	0.0	0.0	0.0	12.3
Direct Tax	0.0	0.0	0.0	0.0	0.0	549.6	345.2	204.3	0.0	0.0	0.0	549.6
Indirect Tax	522.8	87.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	610.7
Tariff	44.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.2
Leisure	0.0	0.0	0.0	0.0	0.0	5599.1	2480.6	3118.5	0.0	0.0	0.0	5599.1
Capital (Saving)	0.0	0.0	0.0	0.0	0.0	1182.4	665.3	517.0	0.0	0.0	566.3	1748.7
Import	4637.1	616.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5253.1
Total	11978.1	18118.7	3107.6	655.3	1742.1	11104.1	5939.2	5164.9	1748.7	1216.7	5253.1	0.0

SAM Latvia 2000 (Unit: Lats, Millions)

	Goods	Service	L	K (equipment)	K (structure)	C	C (Unskilled)	C (Skilled)	I	G	X	Total
Goods	1381.0	1125.1	0.0	0.0	0.0	1653.9	983.9	670.1	566.3	8.6	1291.5	6026.5
Service	1507.3	8684.4	0.0	0.0	0.0	1262.9	678.9	584.1	524.4	988.4	639.4	13606.9
Labor	543.8	1622.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2166.3
(Unskilled)	443.1	907.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1350.9
(Skilled)	100.7	714.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	815.4
Capital equipment	82.4	630.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	712.8
(Unskilled)	42.6	325.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	368.0
(Skilled)	39.9	305.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	344.9
Capital structure	158.9	1214.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1373.7
(Unskilled)	82.0	627.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	709.1
(Skilled)	76.9	587.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	664.6
Households	0.0	0.0	2166.3	712.8	1373.7	0.0	0.0	0.0	0.0	0.0	0.0	4252.8
Government	429.5	68.7	0.0	0.0	0.0	498.8	289.4	209.4	0.0	0.0	0.0	997.0
Bond	0.0	0.0	0.0	0.0	0.0	133.0	78.9	54.2	0.0	0.0	0.0	133.0
Direct Tax	0.0	0.0	0.0	0.0	0.0	365.7	210.6	155.2	0.0	0.0	0.0	365.7
Indirect Tax	381.7	68.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	450.5
Tariff	47.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7
Leisure	0.0	0.0	0.0	0.0	0.0	4747.4	3044.4	1703.0	0.0	0.0	0.0	4747.4
Capital (Saving)	0.0	0.0	0.0	0.0	0.0	837.2	475.8	361.4	0.0	0.0	253.6	1090.8
Import	1923.5	261.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2184.5
Total	6026.5	13606.9	2166.3	712.8	1373.7	9000.2	5472.3	3527.9	1090.8	997.0	2184.5	0.0

SAM Lithuania 2000 (Unit: Litas, Millions)

	Goods	Service	L	K (equipment)	K (structure)	C	C (Unskilled)	C (Skilled)	I	G	X	Total
Goods	16168.6	8514.9	0.0	0.0	0.0	20408.9	14030.8	6378.2	3664.6	508.9	17280.4	66546.4
Service	13233.8	55610.0	0.0	0.0	0.0	9661.0	5861.4	3799.6	4974.8	9904.2	3101.4	96485.2
Labor	6263.7	14352.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20616.5
(Unskilled)	5004.8	7447.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12452.4
(Skilled)	1258.9	6905.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8164.1
Capital equipment	782.3	2729.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3511.4
(Unskilled)	544.5	1899.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2443.9
(Skilled)	237.8	829.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1067.5
Capital structure	3662.0	12774.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16436.2
(Unskilled)	2548.7	8890.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11439.6
(Skilled)	1113.2	3883.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4996.6
Households	0.0	0.0	20616.5	3511.4	16436.2	0.0	0.0	0.0	0.0	0.0	0.0	40564.1
Government	4417.1	717.9	0.0	0.0	0.0	5278.1	3346.1	1932.0	0.0	0.0	0.0	10413.1
Bond	0.0	0.0	0.0	0.0	0.0	1461.0	867.6	593.3	0.0	0.0	0.0	1461.0
Direct Tax	0.0	0.0	0.0	0.0	0.0	3817.1	2478.4	1338.6	0.0	0.0	0.0	3817.1
Indirect Tax	3890.1	717.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4608.0
Tariff	527.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	527.0
Leisure	0.0	0.0	0.0	0.0	0.0	38858.9	21294.0	17565.0	0.0	0.0	0.0	38858.9
Capital (Saving)	0.0	0.0	0.0	0.0	0.0	5216.1	3097.7	2118.4	0.0	0.0	3423.3	8639.4
Import	22018.9	1786.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23805.1
Total	66546.4	96485.2	20616.5	3511.4	16436.2	79423.0	47629.9	31793.1	8639.4	10413.1	23805.1	0.0

Appendix 5: Exogenous Shocks for Numerical Experiments

Table A5.1: Numerical Experiments (Benchmark: 1995-2008)
(percent change)

Experiment		Estonia	Latvia	Lithuania
ToT	Goods	14.5	-10.9	29.9
	Services	34.0	8.3	41.8
Capital deepening	Equipment	431.0	774.5	620.5
	Structures	254.3	387.7	184.0
Skill supply	Skilled	53.0	31.0	91.1
	Unskilled	-15.3	-5.8	-12.7

Table A5.2: Numerical Experiments (Sensitivity Analysis: 1995-2000)
(percent change)

Experiment		Estonia	Latvia	Lithuania
ToT	Goods	0.5	-17.8	16.5
	Services	13.9	4.9	32.2
Capital deepening	Equipment	92.7	159.3	143.1
	Structures	54.1	66.5	50.8
Skill supply	Skilled	27.9	-9.1	8.2
	Unskilled	-9.6	-0.5	-2.7

Table A5.3: Numerical Experiments (Sensitivity Analysis: 2000-2008)
(percent change)

Experiment		Estonia	Latvia	Lithuania
ToT	Goods	14.0	8.5	11.4
	Services	17.7	3.3	7.3
Capital deepening	Equipment	175.5	237.3	196.4
	Structures	129.9	192.9	88.3
Skill supply	Skilled	19.6	44.2	76.5
	Unskilled	-6.3	-5.3	-10.2

References

Auerbach, Alan J., Kotlikoff, Laurence, 1987. Dynamic Fiscal Policy. Cambridge University Press, Cambridge.

Barro, Robert J., Lee, Jong Wha, 2013. A new data set of educational attainment in the world, 1950-2010, Journal of Development Economics, Vol. 104(C), pp 184-198.

Bems, Rudolfs, Jönsson Hartelius, Kristian, 2006. Trade deficits in the Baltic states: how long will the party last?, Review of Economic Dynamics, Vol. 9, No. 1, pp 179-209.

Caselli, Francesco, 2005. Accounting for cross-country income differences. In *Handbook of economic growth*, edited by Phillippe Aghion and Steven Durlauf. Amsterdam: North Holland, pp. 679-741.

Eaton, Jonathan, Kortum, Samuel, 2002. Technology, geography and trade. Econometrica, Vol. 70, No. 5, pp. 1741-1779.

Ghez, Gilbert, Becker, Gary, 1975. The Allocation of Time and Goods over the Life Cycle. Columbia University Press, New York.

Goldin, Claudia, Katz, Lawrence F., 2008. The Race between Education and Technology. The Belknap Press of Harvard University Press, Cambridge, MA.

Hall, Robert E., Jones, Charles I., 1999. Why do some countries produce so much more output per worker than others?, Quarterly Journal of Economics, Vol. 114, No. 1, pp 83-116.

Kehoe, Timothy J., Serra-Puche, Jaime, 1983. A computational general equilibrium model with endogenous unemployment: an analysis of the 1980 fiscal reform in Mexico. Journal of Public Economics, Vol. 22, pp. 1-26.

Kehoe, Timothy J., 1996. Social accounting matrices and applied general equilibrium models. Working Paper 563, Federal Reserve Bank of Minneapolis, Minneapolis, MN.

Kehoe, Timothy J., Ruhl, Kim J., 2008. Are shocks to the terms of trade shocks to productivity? Review of Economic Dynamics, Vol. 11, pp. 804-819.

Krusell, Per, Ohanian, Lee E., Ríos-Rull, José Víctor, Violante, Giovanni L., 2000. Capital-skill complementarity and inequality: a macroeconomic analysis. Econometrica, Vol. 68, No. 5, pp. 1029-1053.

Parro, Fernando, 2013. Capital-skill complementarity and the skill premium in a quantitative model of trade. American Economic Journal: Macroeconomics, Vol. 5, No. 1, pp. 72-117.

Polgreen, Linnea, Silos, Pedro, 2008. Capital-skill complementarity and inequality: a sensitivity analysis. Review of Economic Dynamics, Vol. 11, pp. 302-313.

Ripoll, Marla, 2005. Trade liberalization and the skill premium in developing economies. Journal of Monetary Economics, Vol. 52, No. 3, pp. 601-619.

Ruhl, Kim J., 2008. The international elasticity puzzle. Mimeo, University of Texas at Austin.

Simonovska, Ina, Waugh, Michael, 2014. The elasticity of trade: estimates and evidence. Journal of International Economics, Vol. 92, No. 1, pp. 34-50.

Stockman, Alan C., Tesar, Linda L., 1995. Tastes and technology in a two-country model of the business cycle: explaining international comovements. American Economic Review, Vol. 85, pp. 168-185.

Toomet, Ott, 2011. Learn English, not the local language! Ethnic Russians in the Baltic states. American Economic Review. May 2011, Vol. 101, No. 3, pp 526-531.

Whalley, John, 1982. An evaluation of the Tokyo Round Table Agreement using general equilibrium computational methods. Journal of Policy Modeling, Vol. 4, No. 3, pp. 341-361.