Minimum Wage Competition*

Koichi Fukumura† and Atsushi Yamagishi‡

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Abstract

This paper shows that increased factor mobility might cause the "race to the top" in minimum wage settings, contrary to what other studies have suggested. By focusing on geographical labor mobility, we propose a minimum wage competition model and show that minimum wage rates may increase after a significant increase in mobility because it allows each government to less internalize the negative effect of the minimum wage increase. This result is consistent with the data on European countries from the period of the EU's massive enlargement. We also show that minimum wage rates respond positively to increased geographical mobility when (i) mobile workers face significantly worse labor market conditions, (ii) the concerns of economic efficiency are small, and (iii) the share of mobile workers is relatively small. The model also yields a normative implication that coordination in setting minimum wages is needed to achieve a desirable outcome.

JEL classification: H23, H77, I38, J61, J68

Keywords: minimum wage; geographical mobility; intergovernmental competition; immigrants; race to the top.

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†Faculty of Economics, Kagawa University. Email: fukumura@ec.kagawa-u.ac.jp

‡*Corresponding author*. Department of Economics, Princeton University. E-mail: ayamagishi@princeton.edu

1 Introduction

Minimum wage policies are adopted in numerous countries, including both developed and developing ones. Despite the potential concerns that minimum wage policies may cause substantial unemployment, we can easily find many recent examples of minimum wage increases.[1] For example, at the national level, Germany introduced minimum wages in 2015. Minimum wage increases are also widely observed at the subnational level. A prominent example is Seattle, which has decided to gradually increase its minimum wage to $15 per hour starting from 2015.

However, such prevalence of minimum wage increases may be puzzling given the increased mobility of capital and labor in the 21st century. Both prior theoretical and empirical works have suggested that the increased mobility of production factors seems to make governments rely less on minimum wages through various channels. When capital markets are integrated across regions, each region attempts to attract capital through policy instruments. One such typical instrument is undercutting tax rates (Zodrow and Mieszkowski, 1986; Devereux, Lockwood, and Redoano, 2008); however, regions can also attract capital by loosening labor-related regulations because that alleviates the labor costs incurred by firms.[2] For example, Davies and Vadlamannati (2013) and Olney (2013) empirically demonstrate that governments relax labor standards to attract firms or investments. Gabszewicz and van Ypersele (1996) show that governments lower minimum wage rates to attract capital when capital markets are integrated. Regarding labor mobility, the literature on welfare migration suggests that redistributive policies such as minimum wages become less popular as geographical labor mobility increases. Wildasin (1991) shows that even when governments are altruistic toward the poor, in the equilibrium, they provide sub-optimally small redistribution because doing so expels the poor from the region and reduces welfare spending.[3] This hypothesis is empirically confirmed and discussed in various settings (e.g., Brueckner, 2000; Dahlberg and Edmark, 2008; Kattenberg and Vermeulen, 2018).

The role of minimum wages, however, does not seem to decline even after the drastic enhancement of factor mobility. Figure 1 shows the Kaitz index, which is defined as the minimum wage rate divided by the median wage, for European countries belonging to OECD.[4] The massive enlargement of the European

[1] A hot debate continues over whether minimum wage increases cause significant unemployment (e.g., Card and Krueger, 1994; Neumark and Wascher, 2008; Dube, Lester, and Reich, 2016.) In this paper, we abstract from this issue and focus on the effect of increased mobility on minimum wage levels.

[2] Governments also loosen environmental regulations to attract capital. See Cheng, Li, and Liu (2018), Yamagishi (2019), and the references therein.

[3] This result is particularly surprising because in Wildasin's model, the labor of the poor is complementary to that of the rich, and so rich people have an incentive to attract the poor. In our model, immigrants' labor is substitutes for native labor so that natives have an incentive to expel immigrants, and yet minimum wage rates may be increased in equilibrium.

[4] Using the gross or real value of minimum wages *strengthens* the increasing trend of minimum wages. This implies that the presented results are not driven by the changes in the median wage rates. We present the results using the Kaitz index in order to be conservative by partially accounting for the effect of the counties' productivity growth and inflation. Dividing the nominal minimum wage by the median wage is likely to, at least partially, control for these effects and show how much

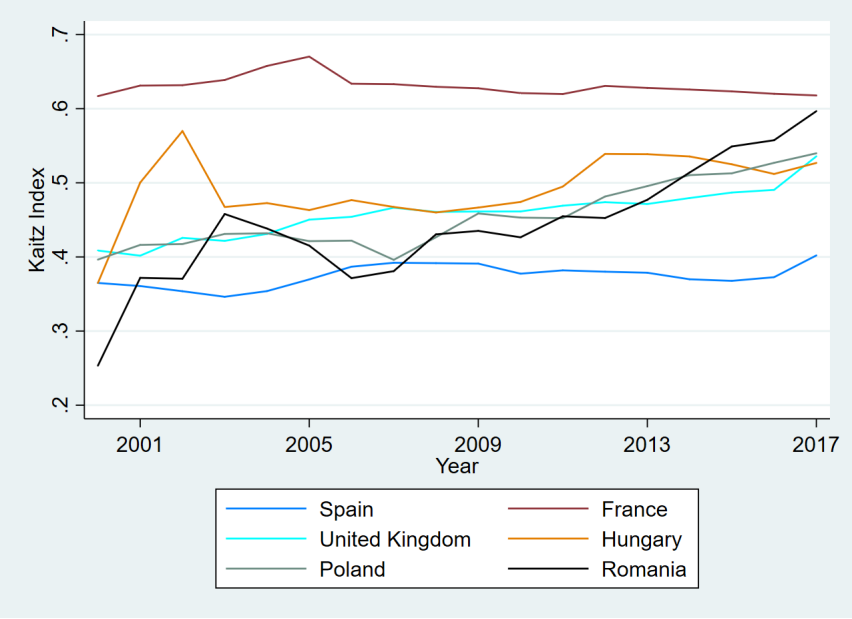

Figure 1: Time trends of the Kaitz index in selected European countries.
Notes. The figure shows the Kaitz index (the minimum wage rate divided by the median wage) from 2000 to 2017 in selected European countries belonging to the OECD. *Source:* OECD Statistics.

Union in the 21st century is likely to cause these countries to experience a significant increase in capital and labor mobility. Still, Figure 1 clearly shows that, during the period, no evidence exists that minimum wage levels are reduced relative to the median wage. Rather, the simple regression analysis reported in Table 1 indicates that minimum wage rates have increased somewhat. Column 1 shows that, over the past 15 years, the Kaitz Index increased by approximately 0.05. This conclusion is strengthened when we confine the sample to Eastern European countries, which have experienced the most significant increase in mobility from the enlargement of the European Union. For these countries, the Kaitz Index has increased by approximately 0.1. The increasing trend is robust in the sense that using other measures, such as the gross and real minimum wage rates, shows even stronger increasing trends.[5] Although these results may not necessarily reflect causal relationships, this pattern questions the view that factor mobility leads to a reduced role of minimum wages and suggests that the opposite may be true; that is, enhanced mobility *increases* equilibrium minimum wage rates.

In this study, we provide a possible explanation for the prevalence of minimum wages in the world of increased mobility. We focus on the geographical mobility of workers and show that increased residential

minimum wages bite in a country. Using the nominal values strengthens the result that minimum wages are increasing.

[5]We do not report the regression analysis using these measures. The article in European Data Journalism Network "Eastern Europe is fast filling huge gap in minimum wages" (`https://www.europeandatajournalism.eu/eng/News/Data-news/Eastern-Europe-is-fast-filling-huge-gap-in-minimum-wages`) provides a graphical illustration of the drastic minimum wage increase in Eastern Europe.

	(1) Kaitz Index (Full sample)	(2) Kaitz Index (Eastern Europe)
Trend	0.003***	0.006***
	(0.000)	(0.001)
N	319	157
R^2	0.766	0.734

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1: Time trends of the Kaitz index in European countries.
Notes. This table shows the regression of the Kaitz index of each country (the minimum wage rate divided by the median wage) from 2000 to 2017 in European countries belonging to the OECD to the linear time trend, along with country fixed effects. See Appendix B for more details.

mobility may make each government internalize less the side effects of minimum wage increases, leading to excessively high minimum wage rates. Thus, minimum wage rates may be increased even if minimum wage policies significantly destroy jobs.

For our purpose, we propose a minimum wage competition model in which each local government sets the minimum wage level. People reallocate after observing minimum wage levels. We consider two types of workers: mobile workers and immobile workers. We refer to the former type as "immigrants" and the latter type as "natives."[6] Immigrants choose where to live by comparing labor market conditions, that is, minimum wage levels and unemployment rates. Taking into consideration the reallocation of immigrants, each government chooses its minimum wage level to balance efficiency and equity. Because reallocation decisions depend on the minimum wage levels of all jurisdictions, each government's policymaking is interdependent. As a result, the equilibrium minimum wage levels are either too low or too high, which is consistent with the data provided in Figure 1.

The key intuition for our race-to-the-top result is that part of the burden of increasing minimum wages may not be incurred by local governments. Suppose that the minimum wage hike causes significant unemployment. In the open economy, mobile workers can escape from the worsened labor market by moving to another place. Such out-migration alleviates the over-supply of labor and benefits the people remaining in the region. Thus, the perceived cost of job destruction due to the minimum wage increase might be smaller in the open economy. On the other hand, when minimum wage increase does not cause much unemployment, it may attract mobile workers. It increases the supply of labor and the benefit for

[6] Our results are more general than these labels suggest. "immigrants" do not have to be foreign individuals as long as their mobility is relatively high. For example, "immigrants" can be interpreted as less competitive people with high unemployment risk, whereas "natives" are those with low risk. The latter may almost always be the median voter if their population share is large. Given that job-seekers have high migration propensity (Greenwood, 1985), our framework can be applied to analyze a decentralized minimum wage setting in a federation. As long as these assumptions are valid, our model could potentially fit such situations.

the immobile workers shrinks. In this case, the perceived benefit of increasing minimum wages is smaller in the open economy, leading to the race-to-the-bottom situation.

The model also yields several interesting empirically relevant predictions. Notably, our results show that the relative performance of immigrants and natives in the labor market, the degree of concerns for economic efficiency, and the number of immigrants play a key role in determining whether increased mobility induces hikes in minimum wages.[7]

Beyond their explanatory and predictive power, our results have an important normative implication that governments need to coordinate in order to set minimum wage levels. In particular, the coordination is needed within a federation in which workers' mobility is quite high. The United States allows each state to choose its minimum wage level, as long as the selected amount is higher than the federal minimum wage. If "race to the top" occurs and many states attempt to increase their minimum wage, setting a minimum wage floor may not be a useful coordination device and leads to an undesirable outcome. In such a case, it may be useful to introduce "minimum wage ceiling," which defines the highest minimum wage available for each state. In contrast, other countries such as France and Japan set minimum wages in a more centralized manner. Our result implies that such a centralized minimum wage setting may be better at preventing the inefficiency caused by minimum wage competition.[8] For example, our result promotes the introduction of the EU-wide minimum wage rate.[9]

Although positive and negative aspects of minimum wages have been analyzed extensively, relatively little attention has been paid to minimum wage setting. Closely related works are Gabszewicz and van Ypersele (1996), Green and Harrison (2010), and Li, Kanbur, and Lin (2018), which address the decentralized minimum wage setting. However, none of them consider the role of migration. Gabszewicz and van Ypersele (1996) introduce capital mobility and show that minimum wage rates become excessively low to attract capital. Green and Harrison (2010) empirically question this mechanism and argue that standards of fairness play a key role. Our analysis highlights that migration responses to minimum wages may trigger intergovernmental competition, which may lead to a "race to the bottom" or a "race to the top." Li, Kanbur, and Lin (2018) empirically reveal that decentralized minimum wage settings in China exhibits strategic complementarity, but they are agnostic about whether the minimum wage competition

[7] The last implication on the number of immigrants is also important in justifying the application of our model to an international context. Arguably, the share of international immigrants to the national population is not large in the real world. However, our model predicts that the race to the top occurs in exactly such a situation.

[8] An important counterargument for the centralized minimum wage setting is based on information asymmetry. Because local governments tend to have richer information on local economic conditions, one should utilize this information to improve efficiency. The Japanese system is hybrid in the sense that it is highly centralized but also utilizes local information to some extent. Japanese minimum wage levels vary at the prefectural level. The prefectural government can set its minimum wage level, but the decision is largely determined by the central government. However, a prefectural government can, to some extent, adjust the change in the minimum wage (Hara, 2017; Yamagishi, 2019).

[9] The minimum wage rates do not have to be uniform across countries. What matters here is removing each government's discretion over its minimum wage.

is characterized by "race to the bottom" or "race to the top."[10] We provide a theoretical framework to consider this issue and provide several characterizations. Several papers investigate political economic determinants and bargaining processes in setting the minimum wage (e.g., Cox and Oaxaca, 1982; Blais, Cousineau, and McRoberts, 1989; Boeri, 2012). We do not consider detailed political decision-making processes and simply assume that a government chooses minimum wage rates by paying attention to both GDP and the utility of minimum wage workers.

Our analysis is motivated by several recent papers that show that people's migration decisions are indeed affected by minimum wage policies.[11] In particular, Cadena (2014) and Monras (2019) show that, in the United States, low-skilled people may migrate out of states experiencing minimum wage increases. With such empirical findings in mind, we consider what happens if local governments take into account such reallocations when setting minimum wages. Relatedly, McKinnish (2017) shows that, in the United States, people in a state with a high minimum wage commute to a state with a low minimum wage. Even if residential reallocation does not occur, our analysis can be directly applied to cross-state commuting. Theoretically, the classical work of Harris and Todaro (1970) and others have pointed out that migration decisions depend on minimum wages. The recent empirical evidence emphasizes the importance of this mechanism.

This paper is also closely related to the literature on welfare migration (Brueckner, 2000; Cremer and Pestieau, 2004). Wildasin (1991) shows that each local government inefficiently reduces its welfare benefit level to save on spending, leading to the "race to the bottom" in the welfare level. This model is not directly applicable to the minimum wage because whether or not the minimum wage is desirable and who benefits more from it is unclear a priori. We propose a minimum wage competition model that features migration and that can be used when discussing decentralized minimum wage settings. We show that whether "race to the bottom" or "race to the top" occurs depends on the effect of minimum wage increases on the number of jobs, which in turn depends on various factors.

This paper is also related to the recent literature on enforcement policy toward unauthorized migrants in a decentralized setting (Bandyopadhyay and Pinto, 2017; Miyagiwa and Sato, 2019). In these models, each jurisdiction's enforcement entails an externality due to decentralization and migration, such as in this

[10] Li, Kanbur, and Lin (2018) state that "race to the top" might occur when local governments face the shortage of labor supply. This argument implicitly assumes that minimum wage workers are attracted by minimum wage hikes, which is consistent with some empirical works (e,g,, Giulietti, 2014) but inconsistent with others (e.g., Cadena, 2014; Monras, 2019). In practice, the presence of significant unemployment among low-skilled workers implies that the labor force is not fully utilized and that the shortage of labor might not be a serious problem. We show that "race to the top" may occur when the unemployment due to minimum wage increase is less internalized in the open economy, which seems to be plausible in EU given the concern that the inflow of immigrants worsens labor market conditions.

[11] Not limited to the minimum wage changes, Cadena and Kovak (2016) show that Mexican-born immigrants moved in response to labor market shocks such that they equilibrate the labor market in the United States as a whole. More broadly, Kennan and Walker (2011) show that migration decisions in the United States are significantly affected by concerns about the labor market.

work and in the literature on welfare migration. We focus on minimum wage policies and consider the case in which the minimum wage is applied equally to natives and nonnatives. In this sense, unauthorized immigrants are not considered in our paper because they are typically not protected by minimum wage laws. In contrast, expelling legal immigrants is not legally allowed and results in this literature are not directly applicable to minimum wage settings. Our results show that a government may use minimum wage policies as an indirect (and politically acceptable) policy instrument to repel legal immigrants.

The rest of this paper is organized as follows. We propose the model in Section 2. The equilibrium in the open and closed economies is derived in Section 3. In Section 4, we compare an equilibrium in the open and closed economies by relying on both analytical and numerical results. Section 5 concludes the study.

2 Model

We assume immobile residents (natives) and mobile residents (immigrants).[12] Although we use the labels "natives" and "immigrants" for notational simplicity, the model can also be applied in other contexts as long as relatively mobile and immobile workers exist. The population of the natives in each region is normalized to one. The population of the immigrants is denoted by N, which is fixed if the economy is closed and determined endogenously if it is open.[13] We assume that people in region i always work at the minimum wage level in that region (i.e., $\underline{w}_i$). When unemployed, we simply assume that they earn nothing and the utility level is zero.[14] We further assume that both natives and immigrants are expected income maximizers.[15]

Let E^N and U^N be the number of employed and unemployed natives, respectively. Similarly, we define E^I and U^I for immigrants. These variables are time dependent: we assume that the period $t = 1, 2, ...$ and is related by the following Markov transition dynamics. Let δ^N and δ^I be the job separation rate of natives and immigrants in each period, respectively. As in standard labor search models, we assume that these variables are exogenously given. We denote the job finding rate by ρ, which is common for both natives and immigrants. Heterogeneity in the job finding rate can be introduced without altering the main

[12] It turns out, however, that at the symmetric equilibrium we focus on, mobile residents choose not to move even if they can. Thus, what is important is that some people can *potentially* move.

[13] Note the slight abuse of notation: The usual N means population, whereas the superscript N indicates "natives."

[14] We can also assume without loss that they earn $b \geq 0$, which is interpreted as the composite of unemployment benefit, home production, and the value of leisure Then, we normalize $b = 0$.

[15] That is, the Bernoulli utility function is linear: $u(w) = w$.

conclusions.[16] ρ is determined endogenously. In the steady state on which we focus, we have

$$E^N = (1-\delta^N)E^N + \rho U^N \tag{1}$$

$$U^N = \delta^N E^N + (1-\rho)U^N \tag{2}$$

$$E^I = (1-\delta^I)E^I + \rho U^I \tag{3}$$

$$U^I = \delta^I E^I + (1-\rho)U^I \tag{4}$$

$$E^N + U^N = 1 \tag{5}$$

$$E^I + U^I = N. \tag{6}$$

Given N and ρ, the steady state would be

$$E^N_* = \frac{\rho}{\rho + \delta^N} \tag{7}$$

$$E^I_* = \frac{\rho}{\rho + \delta^I} N. \tag{8}$$

For simplicity, we assume that the steady state is immediately realized after policy changes. The sum of (7) and (8) is the total labor supply in the steady state.

On the labor demand side, we assume that in each region, there are jobs with various productivity w. The number of jobs with productivity w is exogenously given by the density function g(w).[17] Each job vacancies requires one unit of labor. We suppose that no upper bound exists for the support of w; however, this assumption can be relaxed without modifications to the results.[18] For simplicity, we assume that all workers work at the minimum wage $\underline{w}$ regardless of the productivity of the job w.[19] After they make the job contract, job posters has no incentive to give wage more than $\underline{w}$ to the workers. The remaining output $w - \underline{w}$ is taken by job posters.[20] Expecting that the wage level is $\underline{w}$, jobs with productivity w can

[16] We can express the heterogeneity in the job finding rate by multiplying a parameter $0 < \kappa < 1$ by an immigrant's job finding rate. In this case, the analysis is the same if one redefines the job separation rate of immigrants to be δ^I/κ. It implies that when immigrants have worse job finding rate, our analysis is valid even if the job separation rate is the same ($\delta^I = \delta^N$).

[17] While the exogenous job distribution is common in canonical labor search models and we believe it is a useful starting point, endogenizing the distribution of jobs might yield additional interesting implications. For example, the number of jobs may depend on the population level. As long as the number of immigrants is positively related with the number of jobs, this effect may weaken the incentive of natives expelling immigrants. We assume away this possibility since our objective is to show that labor mobility may lead to the race to the top in minimum wage settings. Whether such an effect is strong enough to overturn our conclusion is an empirical question, and it seems that the available results are mixed. See, e.g., Card (1990) and Cadena (2014).

[18] For technical reasons, we introduce the upper bound in the numerical analysis (Section 4.2). We choose the upper bound such that it does not bind.

[19] This assumption is made to avoid unnecessary complications. What matters for our conclusions is that minimum wages hikes raise the wage level of workers, but may cause job destruction. We obtain qualitatively similar results as long as the wage level when employed is increasing through the minimum wage through, say, some bargaining process. For example, if the wage level is determined by the convex combination of the minimum wage $\underline{w}$ and the job productivity w, the wage level is increasing in the minimum wage and almost the same argument remains valid.

[20] One can interpret that a job is posted by (immobile) skilled workers. In that case, the skilled and the unskilled labor are complementary, as in Wildasin (1991)

be fulfilled if and only if $w \geq \underline{w}$ since rational job posters can secure the zero profit by not posting the job. Thus, all jobs with productivity below $\underline{w}$ always remains vacant.

Now, we can define the total labor demand as

$$D(\underline{w}) \equiv \int_{\underline{w}}^{\infty} g(w)dw. \tag{9}$$

$g(w)$ is the distribution of job productivity. When the minimum wage rate is high, jobs with low productivity are destructed. Note that $D' = -g(\underline{w}) < 0$ and $D'' = -g'(\underline{w})$.

We also define the total production given the minimum wage level $T(\underline{w})$. This production is given by

$$T(\underline{w}) \equiv \int_{\underline{w}}^{\infty} wg(w)dw. \tag{10}$$

$g(w)$ is the distribution of job productivity. When the minimum wage rate is high, jobs with low productivity are destructed. The integrand is the total production of jobs with productivity w. We can easily derive $T' = -\underline{w}g(\underline{w}) < 0$ and $T'' = -g(\underline{w}) - \underline{w}g'(\underline{w})$. For simplicity, we assume $T'' \leq 0$, which is always satisfied if g is uniformly distributed ($g' = 0$) or $g' > 0$ in the relevant range.[21] Note that while the total production declines, the average productivity per employed worker increases in response to the minimum wage increase. Thus, minimum wage hikes selectively destroy jobs with worse productivity.

Given the steady state (7) and (8), N and ρ are determined by the migration condition

$$\overline{U} = \frac{\rho}{\rho + \delta^I}\underline{w}, \tag{11}$$

where $\overline{U}$ is the exogenously given outside utility level workers can obtain by residing in another jurisdiction. The RHS of (11) is the expected utility from residing in the region. Workers decide which jurisdiction to live in given the wage level and the employment probability, as in Harris and Todaro (1970).

In addition, the following (long-run) equilibrium condition for labor supply and demand holds:

$$D(\underline{w}) = E_*^N + E_*^I = \frac{\rho}{\rho + \delta^N} + \frac{\rho}{\rho + \delta^I}N. \tag{12}$$

In the open economy, (11) and (12) determine two endogenous variables N and ρ. In a closed economy in which immigrants cannot move, the number of immigrants in each region (N) is exogenously given. In this case, (12) determines one endogenous variable ρ. We assume that the total number of immigrants in the economy is nN, where n is the number of jurisdictions. Thus, in a symmetric equilibrium, the population of immigrants in each jurisdiction must be N irrespective of mobility.[22]

[21] Strictly speaking, we need the upper bound of job productivity to define the uniform distribution. Additionally, we show that the assumption is satisfied if g is decreasing and linear.

[22] Zodrow and Mieszkowski (1986) use a model with this structure in the context of capital tax competition.

The government is assumed to maximize the weighted average of native minimum wage workers and total production, balancing the gain from improving minimum wage workers' utility with the cost of reducing economic efficiency. More specifically, the government maximizes

$$\max_{\underline{w}} \frac{\rho}{\rho+\delta^N}\underline{w}+\lambda T(\underline{w}), \tag{13}$$

where $\lambda > 0$ is the relative weight on the efficiency since the second term is the total output in a region and corresponds to GDP.[23] The government regards this total output as a welfare measure and cares about it. In addition, the government is concerned about the utility of native workers. Our preferred interpretation is that the government reflects the interest of natives through majority voting (Gabszewicz and van Ypersele, 1996; Cremer and Pestieau, 2004).[24] In this scenario, the government attempts to improve the utility of minimum wage workers to obtain majority votes from such workers or altruistic nonpoor voters. The objective function is particularly reasonable when the median voter is native and concerned about the utility of native minimum wage workers.[25] Moreover, it turns out that including the immigrant workers' utility in the objective function does not alter our main qualitative implications about the "race to the top."[26] Thus, for our primary purpose of explaining such a phenomenon, we avoid unnecessary complications and simply assume that governments ignore the utility level of immigrant workers. The government must follow constraints (11) and (12) if the economy is open and (12) if the economy is closed.

The timing is as follows. First, the government sets the minimum wage level. Second, in an open economy, immigrants reallocate. Finally, the steady state of the economy is immediately realized, and the utility levels are determined.

3 Equilibrium

3.1 Open Economy

The FOC is

$$\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^N}+\lambda T'=0, \tag{14}$$

where

$$\frac{\partial\rho}{\partial\underline{w}}=-\frac{\rho(\rho+\delta^I)}{\delta^I\underline{w}}<0, \tag{15}$$

[23] Note that the GDP already includes the wages paid to native minimum wage workers. Thus, λ is interpreted as the degree of "extra" consideration toward native minimum wage workers.

[24] Other possible interpretations include lobbying and the redistributive motive toward native minimum wage workers.

[25] Gabszewicz and van Ypersele (1996) also consider a situation in which minimum wage workers are the median voters. Here, we assume that the *native* minimum wage worker is the decisive voter.

[26] See Appendix A for more detailed discussions.

which can be obtained by taking the log of (11) and differentiating it.[27] (14) captures the trade-off in raising minimum wages between the increased wage and the job destruction.[28]

Then, the FOC is rewritten as

$$-\frac{\delta^N-\delta^I}{(\rho+\delta^N)^2}\frac{\rho^2}{\delta^I}+\lambda T'=0. \tag{16}$$

The FOC does not have a positive solution unless the first term is positive, that is, $\delta^N<\delta^I$. We assume $\delta^N<\delta^I$ henceforth to focus on an interesting case.[29] Alternatively, from footnote 16, this assumption is satisfied if immigrants' job finding rate is lower than that of natives while the job separation rate is the same.

We should also check the SOC. Differentiating the first term of (16), we have

$$-\frac{\delta^N-\delta^I}{\delta^I}\frac{2\rho\delta^N}{(\rho+\delta^N)^3}\frac{\partial\rho}{\partial\underline{w}}<0. \tag{17}$$

Thus, the first term supports the (local) concavity of the objective function. Because we assume $T''\leq 0$, this assumption implies that the SOC is always satisfied.

At the symmetric equilibrium in which all jurisdictions set the same minimum wage level, the number of immigrants in each jurisdiction is the same across all jurisdictions. If each jurisdiction is initially inhabited by N immigrants, it is also inhabited by N immigrants at the symmetric equilibrium.

At the symmetric equilibrium, three variables $(\underline{w}^o,\overline{U},\rho^o)$ are endogenously determined by the following three equations:[30]

[27] Note that ρ can be determined only by (11), although the government takes both the migration condition (11) and the labor market clearing condition (12) as given because of the immigration responses. Here, the labor market clearing is maintained through the changes in the number of immigrants N. Due to the increased labor supply, ρ is decreasing in the minimum wage rate $\underline{w}$.

[28] Some readers might wonder how minimum wage rates in other regions affect the first order condition (14). In our setting, they matter only through changes in the outside utility $\overline{U}$. This structure is similar to the capital tax competition model of Zodrow and Mieszkowski (1986). In their model, each jurisdiction is infinitesimally small and other jurisdictions' tax rates affect the first order condition only through changes in the net returns to capital determined globally. Thus, whether minimum wage competition is strategic substitutes or strategic complements depends on how the policy-making is affected by the level of outside utility $\overline{U}$.

[29] In the opposite case, the utility increases by reducing the minimum wage as long as the migration condition is satisfied with equality. Note that (11) also defines $\rho=\frac{\overline{U}\delta^I}{\underline{w}-\overline{U}}$. If the minimum wage is so low that the migration condition does not hold even if $\rho=1$, then no migrant flows in.

[30] Superscript "o" indicates the equilibrium values in the open economy. In this case, $\overline{U}$, which is endogenously determined but taken as given by each jurisdiction. The equilibrium value of $\overline{U}$ is determined by equation after substituting the equilibrium minimum wage rates and the job finding rate. This structure of the model is analogous to the capital tax competition model of Zodrow and Mieszkowski (1986) in which the global net return to capital is determined in the similar way.

$$-\frac{\delta^N-\delta^I}{(\rho^o+\delta^N)^2}\frac{(\rho^o)^2}{\delta^I}+\lambda T'(\underline{w}^o)=0 \tag{18}$$

$$\overline{U}=\frac{\rho^o}{\rho^o+\delta^I}\underline{w}^o, \tag{19}$$

$$D(\underline{w}^o)=\frac{\rho^o}{\rho^o+\delta^N}+\frac{\rho^o}{\rho^o+\delta^I}N. \tag{20}$$

(18) is the FOC of each jurisdiction at the symmetric equilibrium, (19) is the migration condition, and (20) is the equilibrium condition of the labor market in each jurisdiction. The migration condition (19) is the key to induce the minimum wage competition, as it relates the policy of each country through the utility level $\overline{U}$, as in the literature of capital tax competition (Zodrow and Mieszkowski, 1986) and the welfare migration (Wildasin, 1991).

3.2 Closed Economy

In the closed economy, N "immigrant" workers exist in each jurisdiction, and they cannot move to the other jurisdictions. The FOC looks the same as in the case of the open economy:

$$\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^N}+\lambda T'=0, \tag{21}$$

but $\frac{\partial\rho}{\partial\underline{w}}$ is different from that in the open economy because each jurisdiction is not subject to migration condition (11).[31]

Applying the implicit function theorem to (12), we obtain

$$\frac{\partial\rho}{\partial\underline{w}}=\frac{D'}{\delta^N/(\rho+\delta^N)^2+N\delta^I/(\rho+\delta^I)^2}<0. \tag{22}$$

The SOC is not guaranteed unless one makes functional form assumptions. Here, we simply assume that it is satisfied. In conducting a numerical analysis, we present an example that satisfies the SOC.

Then, at the (symmetric) equilibrium, two endogenous variables $(\underline{w}^c,\rho^c)$ are determined by the two equations:[32]

$$\frac{\delta^N}{(\rho^c+\delta^N)^2}\underline{w}^c\frac{D'(\underline{w}^c)}{\delta^N/(\rho^c+\delta^N)^2+N\delta^I/(\rho^c+\delta^I)^2}+\frac{\rho^c}{\rho^c+\delta^N}+\lambda T'(\underline{w}^c)=0, \tag{23}$$

$$D(\underline{w}^c)=\frac{\rho^c}{\rho^c+\delta^N}+\frac{\rho^c}{\rho^c+\delta^I}N. \tag{24}$$

[31] The additional concern toward immigrant workers does not change our main qualitative results. For details, see Appendix A.

[32] Superscript "c" denotes the equilibrium values in the closed economy.

4 Effect of Increased Mobility

4.1 Analytical Characterizations

We assume that the interior equilibrium exists in both the open and closed economies. We obtain the following result on the race to the top/bottom with respect to labor mobility.

Proposition 1. *Suppose the economy is closed such that the migration of immigrants is prohibited. When the economy opens, each jurisdiction has the incentive to marginally increase (decrease) the minimum wage level if the marginal changes in the job finding rate are sufficiently large (small).*

Proof: At the equilibrium values of the closed economy,

$$\frac{\partial \rho}{\partial \underline{w}} = \frac{D'(\underline{w}^c)}{\delta^N/(\rho^c+\delta^N)^2 + N\delta^I/(\rho^c+\delta^I)^2} \tag{25}$$

holds. This equation is arbitrarily close to zero if $D'(\underline{w}^c) \simeq 0$ and goes to $-\infty$ as $D'(\underline{w}^c) \simeq -\infty$. Note that the denominator must be strictly positive and finite because ρ is always between zero and one.

In the open economy, evaluated at the equilibrium values of the closed economy,

$$\frac{\partial \rho}{\partial \underline{w}} = -\frac{\rho^c(\rho^c+\delta^I)}{\delta^I \underline{w}^c}. \tag{26}$$

Because the first-order conditions are of the same form, each jurisdiction has an incentive to marginally increase the minimum wage if $|(25)| > |(26)|$ ($|\cdot|$ expresses the absolute value of the expressions). The opposite incentive arises when $|(25)| < |(26)|$ Clearly, $|(25)| > |(26)|$ holds if $D'(\underline{w}^c)$ is sufficiently close to $-\infty$. ■

Proposition 1 states that labor mobility makes the government raise the minimum wage if the marginal job destruction effect of the minimum wage is large. Intuitively, this proposition can be explained as follows. In the closed economy, the job-destruction effect of raising the minimum wage in jurisdiction i should fall only onto jurisdiction i. However, in the open economy, all jurisdictions are affected by such job destruction because of the labor mobility. If the job destruction effect is strong, such a negative effect should be mitigated by the immigration outflow. If the negative effect is strong, the labor market condition in jurisdiction i is severely damaged. As in Tiebout (1956), immigrants "vote with their feet" and migration outflow occurs. In turn, such an outflow mitigates the negative effect because the excessive labor supply is partly canceled out. The opposite is the case when the job destruction effect is mild. In this case, immigrant workers are attracted by the minimum wage hike because it secures high wages without severe damages to unemployment. However, immigration inflow induces an excessive supply of labor, which increases the damage from a minimum wage increase.

In short, in the open economy, each jurisdiction must "import" or "export" part of the the job destruction effects through immigrants' migration responses. Such a migration flow induces the local government to increase or decrease the minimum wage level from the equilibrium value under the closed economy.

To obtain further insights into the conditions in which the race to the top or the race to the bottom occur, we compare (25) and (26) in the limit case. Rewriting (25) by using (21),

$$\frac{D'(\underline{w}^c)}{\delta^N/(\rho^c+\delta^N)^2+N\delta^I/(\rho^c+\delta^I)^2} = -\frac{\rho^c(\rho^c+\delta^N)}{\delta^N\underline{w}^c} - \lambda T'(\underline{w}^c)\frac{(\rho^c+\delta^N)^2}{\delta^N\underline{w}^c} \tag{27}$$

Subtracting (26) from (27),

$$-\frac{\rho^c(\rho^c+\delta^N)}{\delta^N\underline{w}^c} + (\frac{\rho^c(\rho^c+\delta^I)}{\delta^I\underline{w}^c}) + \lambda g(\underline{w}^c)\frac{(\rho^c+\delta^N)^2}{\delta^N}. \tag{28}$$

The race to the top occurs iff (28) is negative (i.e., $|(27)| > |(26)|$).

We can easily verify that $-\frac{\rho^c(\rho^c+\delta)}{\delta\underline{w}^c}$ is increasing in δ. Because $\delta^N < \delta^I$, the sum of the first term and the second term of (28) is negative. On the other hand, the third term is positive.

Consider a limit case in which $\delta^N = \delta^I$. In this case, the third term dominates and (28) is positive. Thus, the race to the bottom is likely to occur.[33] In contrast, in another limit case of $\lambda = 0$, the third term vanishes and (28) is negative.[34] Thus, the race to the top occurs. Assuming the continuity of the equilibrium, the results in the limit case hold as long as the parameter values are sufficiently close to these cases. Summarizing this argument, we develop the following proposition.

Proposition 2. *Suppose that the economy is closed such that the migration of immigrants is prohibited. When the economy opens, each jurisdiction has an incentive to marginally decrease the minimum wage level if δ^I and δ^N are sufficiently close to each other (i.e., the job destruction rate is similar). In contrast, each jurisdiction has an incentive to marginally increase the minimum wage when λ is sufficiently close to zero (i.e., the concern for the economic efficiency is small).*

Although Proposition 1 is not about the comparison between equilibrium values, it clearly indicates that the "race to the top" of the minimum wage rates is likely to occur when job destruction is severe. Moreover, Proposition 2 provides some characterizations regarding this comparison. Unfortunately, we cannot analytically compare equilibrium minimum wage levels because of the model's complexity. Therefore, in the next subsection, we conduct equilibrium comparisons by specifying functional forms and parameter values. We also provide intuitions behind the results of Proposition 2 in the next subsection when we confirm the implications of this proposition in the numerical analysis.

[33] In this case, each jurisdiction always has an incentive to lower the MW rate in the open economy.

[34] In this case, each jurisdiction always has an incentive to raise the MW rate in the open economy.

4.2 Numerical Analysis

We specify the marginal distribution of the job offer $g(w) = kw^{-\theta}$, where $k > 0$ and $\theta \in (0,1)$. We assume that an upper bound to the productivity $\overline{w} > 0$ exists for minimum wage workers, and $g(w)$ is defined on $[0, \overline{w}]$.[35] Then, we have $D(\underline{w}) = \frac{k}{1-\theta}[\overline{w}^{1-\theta} - \underline{w}^{1-\theta}]$ and $T(\underline{w}) = \int_{\underline{w}}^{\overline{w}} wkw^{-\theta}dw = \frac{k}{2-\theta}\left(\overline{w}^{2-\theta} - \underline{w}^{2-\theta}\right)$. Under this assumption, verifying that the objective function in the closed economy is concave in $\underline{w}_i$ is tedious but straightforward and ensures that the FOC is also sufficient for the optimum. Noting that the SOC is also satisfied in the open economy, we focus on the symmetric local Nash equilibrium.[36]

We are interested in comparing two equilibrium minimum wage rates $\underline{w}^c$ and $\underline{w}^o$. We provide several characteristics based on our numerical analysis. Although we discuss the results by showing only the representative example, we have confirmed that our conclusions are robust to various parameter permutations.[37] In our numerical analysis, we focus on the parameter values that satisfy $0 < \rho < 1$ and $0 < \underline{w} < \overline{w}$ (i.e., inner solutions) at the equilibrium for both open and closed economies. Because our objective is to compare the equilibrium in the open and the closed economies, our results are ensured not to be driven by unrealistically extreme corner solutions.

In the following figures, we refer to the "no equilibrium area" as the parameter values not satisfying $0 < \rho < 1$ and $0 < \underline{w} < \overline{w}$ in either economy. The race to the top area indicates that the equilibrium minimum wage in the open economy is larger than that in the closed economy. On the other hand, the race to the bottom area shows that the equilibrium minimum wage in the open economy is smaller than that in the closed economy.

We first confirm that the characterizations in Proposition 2 are valid even when we conduct equilibrium comparisons. We first discuss the effect of the job separation rates, δ^N and δ^I, using Figure 2. Note that as discussed in footnote 16, high δ also corresponds to a lower job finding rate. Thus, the following result can be interpreted as how the relative position of immigrant workers affects the minimum wage setting.

Result 1. *The race to the bottom ($\underline{w}^c > \underline{w}^o$) is likely to occur when the job separation rates (δ^I and δ^N) are close enough. When they are sufficiently far apart, the race to the top is likely to occur ($\underline{w}^c < \underline{w}^o$).*

Noting that a higher δ implies a higher job separation rate and a higher unemployment rate at the

[35] We assume that $\overline{w}$ is sufficiently large such that the constraint $\underline{w} \leq \overline{w}$ does not bind in all relevant cases. The upper bound $\overline{w}$ is introduced for a technical assumption—it ensures that relevant integrals are properly defined. The upper bound seems natural since we focus only on the low-skilled minimum wage workers. Moreover, the value of $\overline{w}$ does not seem to affect the results of the numerical analysis in an essential manner.

[36] The focus on such a local equilibrium is often done in spatial models. In the context of minimum wages, drastic adjustments to the minimum wage rate are rare and the local equilibrium concept seems practically relevant. In related contexts, Bayindir-Upmann and Ziad (2005) show that the existence of a local equilibrium can be guaranteed in standard capital tax competition models, whereas the existence of the full-fledged Nash equilibrium cannot be guaranteed. Krasa and Polborn (2014) also adopt such an equilibrium concept in analyzing a spatial electoral model with differentiated candidates.

[37] The results under other parameter values are available on request.

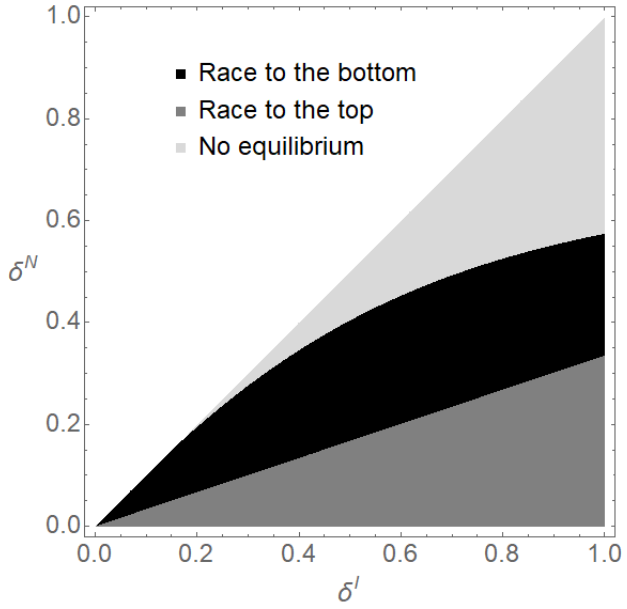

Figure 2: **Race to the Top and Race to the Bottom on the $\delta^I - \delta^N$ plane.**

Notes: Other parameter values are $\lambda = 0.25, \theta = 0.6, k = 1, N = 4, \overline{w} = 4$. See Table A for the description of the parameters.

steady state, the first part of Result 1 confirms the implication of Proposition 2: when immigrants and natives face similar labor market conditions, then the race to the bottom is likely to occur. The second part of Result 1, in contrast, states that the "race to the top" occurs when immigrants are in a disadvantaged position in a labor market. Intuitively, when immigrants and natives face similar labor market conditions, natives cannot improve their welfare by changing minimum wage rates because such an improvement is offset by the migration response of immigrants who are attempting to exploit the improved labor market condition. Thus, each government essentially cares only about efficiency and ends up choosing low $\underline{w}$. In contrast, suppose that immigrants face worse labor market conditions than natives. Then, in response to minimum wage increases, they cannot accept the minimum wage increase because they face severe labor market conditions with the low employment rate. Indeed, they receive smaller marginal gain in the expected utility when the minimum wage marginally increases.[38] It induces out-migration and the negative impact of the minimum wage hike on the job finding rate reduces, leading natives to increase the minimum wage rates.

This result implies that the relative position of immigrants and natives in the labor market is crucial to understanding how the decentralization of minimum wage setting affects the economy. This prediction can be tested empirically. For example, Peracchi and Depalo (2006) find that, in European countries, immigrants face worse labor market conditions than natives. Result 1 suggests that this finding is consistent

[38] For the formal argument, see footnote 42 in Appendix A.

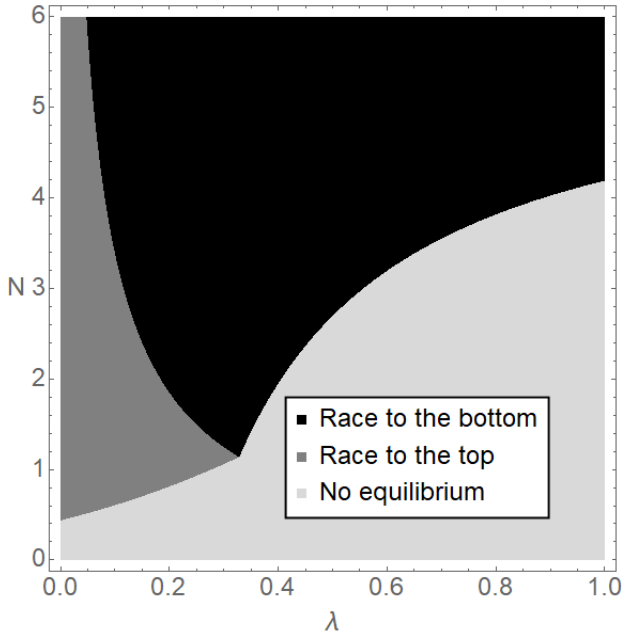

Figure 3: **Race to the Top and Race to the Bottom on the $\lambda - N$ plane.**

Notes: Other parameter values are $\delta^N = 0.25, \delta^I = 0.6, \theta = 0.6, k = 1, \overline{w} = 4$. See Table A for the description of the parameters.

with the recent increase in minimum wage rates in the European Union.[39]

We next discuss how the concern for efficiency affects the results. In Proposition 2, a smaller concern for efficiency (i.e., smaller λ) is likely to lead to the race to the top. We confirm this result in the context of equilibrium comparisons:

Result 2. *The race to the top ($\underline{w}^c < \underline{w}^o$) is likely to occur when each region does not care much about efficiency (i.e., λ is small enough). The race to the bottom is likely to occur when λ is sufficiently large.*

The typical situation is shown in Figure 3. This result is consistent with Proposition 2, and the intuition is as follows. Suppose that the government does not care about production efficiency. In the closed economy, the government does not want to increase the minimum wage rate too much because the disemployment effect may reduce the number of jobs and the utility of native workers. However, this mechanism does not work in the open economy. In the open economy, the disemployment effect can be exported to other regions through migration responses. Even when a job is lost, it induces an outflow of immigrants and the labor market condition for natives is not severely damaged. This situation leads to a continual increase in the minimum wage rate, resulting in the race to the top.

An interpretation about the value of λ is that λ represents how well GDP measures the national welfare. If GDP is a poor measure of people's utility for reasons such as distributional considerations of

[39] See also Drinkwater (2017).

income, then λ is likely to be small. Another interpretation is that λ captures the political preferences. More specifically, when governments are controlled by left-wing parties that care little about economic efficiency, the race to the top is more likely to occur.

Result 2 also underscores that our result is not driven by the shortage of labor. As Li, Kanbur, and Lin (2018) argue, it might be expected that governments raise minimum wage rates in the open economy to attract labor force. However, Result 2 points out that the race to the top takes place in our model if the government does not care much about the economic efficiency, which is clearly improved by mitigating the labor insufficiency. Rather, as identified in Proposition 1, our results are driven by the export and import of the job destruction effects of minimum wages through migration responses.

We report several additional results. First, using Figure 3, we discuss the effect of immigrants' population size.

Result 3. *The race to the top ($\underline{w}^c < \underline{w}^o$) is likely to occur as the population of immigrants (N) shrinks.*

Intuitively, the result follows because immigrants' population size is internalized in the closed economy but not in the open economy. In the closed economy, the increased N implies a smaller effect of the minimum wage increase on the job finding rate (see equation 22). Thus, as N becomes larger, the incentive of natives to raise the minimum wage grows. However, in the open economy, the number of immigrants is now an endogenous variable. This variable is adjusted such that the utility of immigrants is equalized; thus, the population size is not related to the effect on the job finding rate. Thus, $\underline{w}^c < \underline{w}^o$ is more likely to hold as N becomes smaller. This result is also empirically relevant because the population size of mobile workers such as immigrants can be inferred from the data. The race to the top is more likely to occur in a situation in which not many mobile workers exist.[40]

Finally, we touch on the quantitative implications of the model. These implications should be interpreted with caution because our model is not created to yield quantitative implications. Still, these implications may provide some sense as to the degree of impact that increased mobility has on equilibrium minimum wage rates. We provide several numerical examples in Table 2. The top four rows in the table are the race-to-the-top results, and the last row is the race-to-the-bottom result. For example, the first row suggests that, by opening the economy, the minimum wage level increases 1.183 times more than in the closed economy. Consequently, the unemployment rate of natives also increases from 9.5 percent to 23.7 percent by opening the economy. The remaining rows except for the last one also show similar results, although the magnitude varies with the parameters. The last row represents the race-to-the-bottom results. Here, the difference from the first row is the number of immigrants in the economy, and we

[40] The result can also be informally seen by investigating the expression (25). If the other parameters are fixed, the denominator of (25) becomes larger as N becomes larger, reducing the absolute value of (25). Proposition 1 then implies the race to the top.

Parameters $\{\delta^I, \delta^N, \lambda, k, \theta, \overline{w}, N\}$	open/closed	Minimum wage	ρ	Unemployment
{0.06, 0.05, 0.1, 0.75, 0.6, 4, 0.1}	closed	1.61402	0.47645	0.09498
1.183 times larger than closed	open	1.90871	0.16133	0.23660
{0.07, 0.06, 0.1, 0.7, 0.6, 4, 0.1}	closed	1.61012	0.33225	0.15296
1.086 times larger than closed	open	1.74906	0.21626	0.21719
{0.08, 0.07, 0.1, 0.7, 0.6, 4, 0.1}	closed	1.60826	0.38948	0.15235
1.027 times larger than closed	open	1.65147	0.33535	0.17269
{0.05, 0.04, 0.1, 0.8, 0.6, 4, 0.1}	closed	1.61996	0.99410	0.03868
1.285 times larger than closed	open	2.08103	0.10942	0.26770
{0.06, 0.05, 0.1, 0.75, 0.6, 4, 0.5}	closed	1.59903	0.10713	0.31820
0.927 times larger than closed	open	1.48242	0.13233	0.27423

Table 2: Numerical examples: Race to the tops and race to the bottom
The unemployment rate is calculated using the following formula: $\delta^N/(\rho+\delta^N)$. This rate represents the native unemployment rate, which does not indicate the unemployment rate of the entire economy, including the immigrants. See Table A for the description of the parameters.

now obtain the race-to-the-bottom result, which is consistent with Result 3. In this case, by opening the economy, the minimum wage level decreases along with a decline in the unemployment rate.

Overall, we find that, in most cases, the minimum wage rate does not increase too drastically in the case of the race to the top. The equilibrium minimum wage rate typically becomes 1–1.3 times as large as that under the closed economy. This result is consistent with the empirical pattern presented in Figure 1 and Table 1, showing that minimum wage rates of European countries are moderately increased after the EU enlarged. However, Table 2 shows that even a seemingly moderate minimum wage response may cause substantial unemployment. Thus, even when the equilibrium minimum wage rate responds moderately, one should be careful about the cost of the decentralized minimum wage setting.

5 Concluding Remarks

This paper challenges the view that economic integration, which facilitates factor mobility, leads to a smaller role of minimum wage policies. By focusing on geographical labor mobility, we propose a minimum wage competition model and show that minimum wage rates may increase after a significant increase in residential mobility. This result seems consistent with the data on European countries during the period of the massive enlargement of the EU. We also characterize when such an increase is likely to take place and indicate that the "race to the top" is likely to occur when (i) immigrants face significantly worse labor market conditions, (ii) the concerns over economic efficiency are small, and (iii) the share of immigrants is relatively small. These three predictions are empirically relevant and can serve as a benchmark for predicting and evaluating governments' reactions after economic integration. In addition, the model yields a normative implication that coordination in setting minimum wages is needed to achieve a

desirable outcome.

Our model is highly stylized and has several limitations. First, we made several simplifications to make the model tractable. For example, investigating the role of countries' asymmetry seems illuminating. Our results, which are based on the assumption of the small open economy, can be thought as describing a small country in size. On the other hand, a large country is likely to be less affected by the mobility increase. Thus, our results imply the heterogeneous impact of mobility increase on small and large countries. Still, investigating the effect of the other types of asymmetry, such as production technology, on the equilibrium minimum wage rates is interesting. Another interesting extension is to introduce capital mobility. We have mentioned in the introduction that Gabszewicz and van Ypersele (1996) show that capital mobility induces the race to the bottom in minimum wages, which we do not observe in the current European countries. Still, studying the interactions between capital and labor mobility might yield additional implications. Moreover, Bhattacharya and Sen (2018) recently show that the race-to-the-top result in governments' wage setting may be obtained in the presence of multinational firms. In such a context, capital mobility might even strengthen our result obtained by focusing on the labor mobility. We assume a simple political economic structure in which governments reflect the preference of homogeneous native workers. However, incorporating potential political conflicts between natives and immigrants, as exemplified in Dolmas and Huffman (2004), Boerner and Uebelmesser (2007), and Alesina, Miano, and Stantcheva (2018), may yield interesting implications.

Finally, evaluating the welfare cost of minimum wage competition using richer structural models would be helpful in discussing the optimal form of political institutions. This would be particularly fruitful under imperfect mobility. Our model contrasts the case of perfectly open and closed economy for analytical tractability. Our analysis can be regarded as the most drastic form of reduction in the migration cost, and introducing the mobility cost would not change our qualitative conclusions about the reduction in the mobility cost. However, to get a quantitative implication about the impact of economic integration, one needs a richer model where the mobility cost is explicitly incorporated and how much economic integration would reduce the cost is specified. These issues are left for future work.

Appendix A Taking into Account Immigrants' Utility

We consider the case when the governments take into account immigrants' utility, and argue that the analysis in the main text remains valid with only minor modifications. For the purpose, consider the situation where $\mu \frac{\rho}{\rho+\delta^I} \underline{w}$ is added to the objective function (13), where $\mu > 0$ is the weight associated with immigrants' expected utility. Note that in the open economy, the utility of the immigrant workers is fixed, and the objective function is equivalent to (13).[41] Hence, the change in the objective function affects only the analysis in the closed economy.

[41] A delicate issue here is that when the immigrants' utility is fixed, the first order condition is virtually $\left[\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial \rho}{\partial \underline{w}} + \frac{\rho}{\rho+\delta^N}\right] + \lambda T' = 0$, not $(1+\mu)\left[\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial \rho}{\partial \underline{w}} + \frac{\rho}{\rho+\delta^N}\right] + \lambda T' = 0$. Note that the latter FOC is obtained by

Under the new objective function, in the closed economy, the first-order condition consists of the original FOC (21) and the additional term $\mu\left[\frac{\delta^I}{(\rho+\delta^I)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^I}\right]$. However, even when λ is zero, the solution is bounded because the job finding rate ρ approaches zero as $\underline{w}$ goes to infinity, which is clearly undesirable for workers. It especially implies that the result that the race to the top is likely to occur when $\lambda \simeq 0$ is preserved.

If the government cares only about the natives' utility in the sense that the immigrants' utility $\frac{\rho}{\rho+\delta^I}\underline{w}$ is replaced with $\frac{\rho}{\rho+\delta^N}\underline{w}$, then the first order condition in the closed economy is $(1+\mu)\left[\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^N}\right]+\lambda T'=0$. Because we can show that $\left[\frac{\delta^I}{(\rho+\delta^I)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^I}\right]<\left[\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^N}\right]$, it implies $\left[\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^N}\right]+\mu\left[\frac{\delta^I}{(\rho+\delta^I)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^I}\right]+\lambda T'<0$.[42] Thus, evaluated at the situation where the government cares only about natives' utility, it has an incentive to decrease the minimum wage rate when it starts considering the utility of immigrants. This result suggests that considering immigrants' utility lowers the minimum wage rate in the closed economy. Moreover, this incentive is stronger as the difference between δ^N and δ^I expands. These results are consistent with the characterizations in Proposition 2, which states that the "race to the top" (i.e., higher minimum wage rate in the open economy than in the closed economy) is more likely to occur when λ is small or δ^I is much larger than δ^N.

Appendix B Details on the Empirical Analysis

We use the data on the Kaitz index of European countries affiliated with OECD during 2000-2017 , which is taken from OECD statistics. The regression specification is

$$Kaitz_{i,t} = \beta t + country_i + \varepsilon_{it},$$

where i denotes the country, t denotes the year, and ε_{it} is the error term. We report the OLS estimates of β. In the first column are the countries in the sample, including Belgium, the Czech Republic, Spain, Estonia, France, the United Kingdom, Greece, Hungary, Ireland, Lithuania, Luxembourg, Latvia, the Netherlands, Poland, Portugal, Romania, the Slovak Republic, and Slovenia. Note that we eliminate Germany from the sample because it only recently introduced the minimum wage. In the second line, countries in the sample are the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, the Slovak Republic, and Slovenia.

We have also tried a specification in which the linear time trend is replaced with the dummies indicating the event after the enlargement of the EU. Since EU gained new members in 2004, 2007, and 2013, we have defined three dummies $I(t \geq 2004), I(t \geq 2007)$, and $I(t \geq 2013)$. This regression leads us to the similar conclusion as our main specification. Among the estimates the largest one is $I(t \geq 2013)$, implying either that the recent enlargement of EU had the strongest impact or that the adjustment of minimum wages were not immediate. The lag in the treatment effect seems natural in this context because geographical labor reallocation is generally time-consuming. Indeed, even without geographical reallocation, Meer and West (2016) show that the negative effect of minimum wages appears gradually.

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replacing the immigrants' utility by that of natives. While they are quite similar, the relative weight on the economic efficiency is different. This effect might decrease the minimum wage rate in the open economy, making the race to the bottom more likely. Still, as we discuss in this Appendix, considering immigrants' utility may also bring down the minimum wage rate in the closed economy, making ambiguous whether the race to the top is more likely.

[42] The additional term in the first order condition can be rewritten as $\mu\frac{1}{1+\delta}\left[\frac{1}{\frac{\rho}{\delta}+1}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\rho\right]$ with $\delta=\delta^I$. As long as the bracket term is positive for $\delta\in[\delta^N,\delta^I]$, which is a sufficient but not necessary condition, we can show by taking derivatives that the whole expression is decreasing in δ. It implies $\left[\frac{\delta^I}{(\rho+\delta^I)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^I}\right]<\left[\frac{\delta^N}{(\rho+\delta^N)^2}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\frac{\rho}{\rho+\delta^N}\right]$. This means that the marginal increase of the expected utility of the immigrants is smaller at the equilibrium. Note also that $\left[\frac{1}{\frac{\rho}{\delta}+1}\underline{w}\frac{\partial\rho}{\partial\underline{w}}+\rho\right]$ must be positive at $\delta=\delta^N$ from the first order condition in the case of $\delta=\delta^N\simeq\delta^I$. Thus, the sufficient condition might be violated only when δ^I is quite different from δ^N.

Parameter	Description	Parameter	Description
δ^N	job separation rate of natives	N	number of immigrants
δ^I	job separation rate of immigrants	λ	the relative weight on the efficiency
θ, k	distribution parameters of the job offer (used only in Section 4.2)	$\overline{w}$	the upper bound of the productivity (used only in Section 4.2)

Table A: Parameters of the model

Appendix C Parameters Table

We summarize exogeneous model parameters in Table A for the reader's convenience.

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