# Immigration Aversion Under Labor Bargaining

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The recent salience of immigration as an issue among segments of the population in wealthy countries has often been understood as a product of tension between economic interests and cultural preferences. However, such explanations largely ignore differences in power between immigrant and native communities and the cohesion of local community institutions. This article develops a bargaining model that highlights how power asymmetries between workers and employers interact with community cohesion to result in immigration aversion. Community cohesion among both migrant and native workers is modeled through their fallback positions. We show that the salience of immigration depends on the bargaining power of native and migrant workers. Further, we demonstrate that if the bargaining power of both native and migrant workers are low enough, then immigration aversion can exist even if immigration does not reduce labor demand for native workers.

Keywords: bargaining power, community and identity, immigration and labor

JEL Classifications: J61, C78, N3

## 1 Introduction

Literature on immigration overwhelmingly shows little or no effect on wages and employment of native workers and significant positive effects on productivity and growth. And yet, immigration aversion persists in many rich countries, especially as the issue has gained salience among rightwing parties in the United States, Canada, and Western Europe (Garand, Xu, and Davis 2017; Dennison and Geddes 2018; Hatton 2020). This disconnect between the economic effects of immigration and political sentiments is most often explained through tensions between racial and cultural preferences and economic interests, which are not necessarily separate (Hainmueller and Hopkins 2015; Dustmann and Preston 2019; Miller 2023; Alesina and Tabellini 2022; Ajzenman, Dominguez, and Undurraga 2022). Alternatively, intolerance

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for immigrants by native workers may be closely linked to broader increases in inequality (Haight 2013).

In recent decades, the bargaining power of native workers has been under attack with declines in unionization rates, safety nets, and large urban/rural splits in employment, wage, and income growth (BLS 2021; Department for Environment, Food, and Rural Affairs 2021; Economic Research Service 2022; Fulton 2015; Guzman et al. 2018; Kopparam 2020). Additionally, recent empirical findings suggest that better labor market protections mitigate negative perceptions of immigrants (Foged, Haseger, and Yasenova 2022; Bächli and Tasankova 2021). However, most current mainstream models of immigration impacts have neoclassical foundations that do not take into account labor market imperfections. Thus, considering broader questions of bargaining power, community, and their relationship to immigrant sentiment in a context more deeply rooted in political economy can highlight interesting connections.

In this paper, we build a bargaining model that seeks to illustrate these relationships between the bargaining power of native and immigrant workers and the strength of their communities via the fallback position. Capitalists bargain with native workers with the threat of employing immigrants. We show that when native and migrant workers have little bargaining power visà-vis an employer then immigration can generate aversion despite growth in labor demand. Such a model can help explain why immigration aversion persists despite its net positive economic effects. This work contributes to the literature by offering a novel way to explain the interaction between community strength, bargaining power, and cultural preferences in shaping attitudes towards immigrant workers by natives, providing a theoretical foundation for further exploration in this area.

The remainder of the paper is organized as follows. Section 2 reviews literature on the economic effects of immigration, cultural connections, and labor market protections and then discusses the usefulness of a Nash bargaining model to examine this question of political economy. Section 3 presents the bargaining model and results. The final section links cases from the model to periods from the past century of labor history in the United States before offering some concluding thoughts and suggested avenues for future research.

## 2 Literature Review

The use of national divisions within the working classes by capitalists in bargaining was highlighted by Marx (1977, cited by Haight (2013)), who articulated the role of national identities in legitimating the exploitation of workers. More recent work in political economy explores these dynamics more carefully. Haight (2013), for instance, explores the political economy of inequality and intolerance more broadly in the "Intolerance Multiplier" framework. Growing intolerance of other groups – including immigrants – can be used by the owning class to undermine resistance to the appropriation of more national income. As he puts it, "bigotry

invites acquiescence to inequality...but inequality creates frustrations that morph into prejudice" (531). Wisman and Reksten (2024) document the historical use of ideological nationalism in the United States and Western Europe in bargaining between capitalists and native and migrant workers, demonstrating that, in some cases, capitalists stoke and exploit immigration aversion among native workers when they have relatively strong bargaining power. Our model seeks to explore more carefully the conditions under which variations in native worker bargaining power may result in greater intolerance (or aversion) to immigrants or not.

To properly motivate our model, it is helpful to briefly discuss some relevant empirical work on the relationship between immigration, wages, and employment. Reviews on the impact of immigration on native worker wages conclude that likely effects are relatively small (Longhi et al. 2005; Longhi et al. 2010; Peri 2016; Dustmann and Preston 2019; Edo 2019; Alesina and Tabellini 2022). While there is no consensus on the sign of the effect, reviews by Peri (2016), Dustmann and Preston (2019), and Alesina and Tabellini (2022) conclude that wage, employment, and productivity effects are positive. For instance, Ottaviano and Peri (2012) find that immigration to the United States between 1990 and 2006 increased wages for native noncollege workers between 0.3% and 0.6% and college workers between 0.3% and 1.3%. Most cases that find negative impacts are relatively narrow and restrictive. Looking at firmlevel impacts of immigration on wages, Malchow-Møller, Munch, and Skaksen (2012) find that, within firms in Denmark, a 1% increase in the share of low-skilled immigrant workers in a firm reduces the wage of native workers by 0.4%. Much discussion of such varying results across the literature focuses on differences in methodology and model specification (Longhi et al. 2005; Peri 2016; Alesina and Tabellini 2022).

Other papers have looked at the impact of immigrants on productivity and employment, typically at the regional level. Studies using the "shift-share" instrument find that larger flows of immigrants are generally associated with higher levels of productivity in a region (Alesina and Tabellini 2022; Peri 2016). Additionally, non-college educated native workers may shift to more communication-oriented jobs while migrants specialize in jobs with a greater manual component (Peri and Sparber 2009; D'Amuri and Peri 2014; Peri 2016).

Recent literature also tackles the role that labor market institutions such as employment protection and collective bargaining agreements play in mitigating or enhancing the wage and employment effects of immigration. However, there is little consensus on the overall effect of what mainstream economists refer to as "less flexible" institutions. While some empirical work such as Angrist and Kugler (2003), Longhi et al. (2010), Brücker et al. (2013), and D'Amuri and Peri (2014) finds an inverse relationship between labor market flexibility and employment impacts, Foged, Hasager, and Yasenov (2022) and Bächli and Tsankova (2021) find no significant relationship. From the literature discussed above, two points of relative consensus emerge: wage, employment, and productivity effects of immigration on native workers are

relatively small; and labor market institutions, including collective bargaining agreements, account for some of the variation in study outcomes.

Even though the negative economic impacts of immigration are generally thought to be small, opposition to immigration has been an animating issue for minorities of the native population across Europe and North America in recent years. It has led to political polarization on the issue and taken hold in right-wing parties. In the United States in 2019, 83% of Republicans said that a very or somewhat important goal for U.S. immigration policy was increasing deportations of immigrants in the country illegally, while only 31% of Democrats agreed (Daniller 2019). In July 2022, 80% of Republicans in one survey said that the issue of immigration would be "extremely" or "very important" to their vote for Congress (SSRS 2022: 19).<sup>1</sup>

In Europe, the Brexit campaign in the United Kingdom was largely animated by concerns over immigration, even when faced with the consensus among economists that leaving the European Union would make the country poorer and cause other disruptions. Political parties characterized by anti-immigrant positions such as the National Front in France, The League in Italy, Vox in Spain, and Alternative for Germany have seen greater electoral success in recent years, too, than in past decades. Dennison and Geddes (2019) find that, as in the United States, increases in vote shares for anti-immigration parties in Western Europe are spurred by the increased salience of immigration as an issue among a relatively small segment of the population.

What drives the salience of such an issue? While anxieties about immigrants have long been present in the United States and Europe, <sup>2</sup> heightened welfare and racial and cultural concerns seem to dominate in recent years (Dustmann and Preston 2005; Dustmann and Preston 2007; Hainmueller and Hopkins 2014). For instance, Poutvaara and Steinhardt (2018) find that, in Germany, resistance to immigration is strongly correlated with "bitterness" or the idea that life has not turned out as expected.<sup>3</sup> Miller (2023) finds that attitudes in the U.S. regarding ethnocentrism are better predictors of positions on immigration than all economic factors combined. Thus, political polarization on immigration seems to be tied to high levels of ethnocentrism among large portions of the Republican party and a consequent backlash especially among white Democrats (Miller 2023). Mayda, Peri, and Steingress (2022) show that an increase in low-skilled immigrants increased the county-level vote share for the

<sup>&</sup>lt;sup>1</sup> For all voters polled, this number was 70%, consistent with results from the previous 5 years but higher than the roughly 60% who responded this way in several polls before the 2006 midterm elections (SRSS, 2022).

<sup>&</sup>lt;sup>2</sup> See Tabellini (2020), Rosanvallon (2013), and Buhle (2013) for discussions of such historical periods in the U.S. and Rosanvallon (2013) and Chickering (2008) for discussions about periods in France and Germany, respectively.

<sup>&</sup>lt;sup>3</sup> The authors are careful to stress in their findings that the effect cannot be explained by concerns that immigrants are competing in the labor market.

Republican Party between 1990 and 2016, while increases in high-skilled immigrants decreased the share of votes for Republicans. They attribute this to negative public perceptions of low-skilled immigrants and a perception of the Democratic Party as relatively more "pro-migration" than the Republican Party.

We argue that while cultural differences no doubt play a role, there are also more complex factors at play and center the roles of bargaining power and community institutions in shaping fallback positions of both native and immigrant workers. Indeed, Mayda, Peri, and Steingress (2022) find stronger immigration aversion effects in non-urban counties in the United States. Such counties are often experiencing a relative hollowing-out of community institutions such as the government, NGOs and informal clubs, and religious institutions. Bonds among native workers in the presence of regional stagnation and decline (a reduction in social capital) can channel popular discontent among that group (Rodríguez-Pose, Lee, and Lipp 2021). Declines in community support, employment rates, and population of native workers can lead to a perception that communities are fraying and that newcomers are responsible. Such a process reflects Poutvaara and Steinhardt (2018)'s finding that "bitterness" is a strong predictor of immigration aversion and fits with the broad narrative presented in Haight's (2013) Intolerance Multiplier framework.

The value that people place on community is also well-known in the field of stratification economics, which highlights the possibility that groups "invest" in group-based identity to an extent that depends on the social value of such investments (Chelwa, Hamilton, and Stewart 2022). These identities are then arranged into a social hierarchy, reinforcing differences in wealth and social status (Davis 2015). Group identity cultivation among (especially white) native workers and (mostly nonwhite) immigrant workers subjects the latter to exclusion from certain employment or advancement opportunities (Burnazoglu 2023). The social value of identity investment may be higher in a workplace in which workers have little formal collective bargaining power because it can create a stronger fallback position.

Considering the literature on community and stratification, a possible avenue for immigration aversion for native workers is the viability of their fallback position, which we assume to be shaped by access to social networks. This can facilitate the job search process (Reingold 1999; McDonald 2011; Burnazoglu 2023) through spreading knowledge about employment opportunities and possible openings. Additionally, as Fieldhouse and Cutts (2010) point out, there is some evidence that as neighborhoods diversify, social capital can erode among community members of different races and ethnicities. This suggests that natives can *perceive* the diversity that immigration introduces as possibly weakening their ability to find alternate income sources. This may be especially true in regions that previously had high levels of social capital (Rodríguez-Pose, Lee, and Lipp 2021). Perceptions of immigration's effects on the fallback position can also come through the perceived effects on welfare payments and unemployment benefits. Evidence suggests that as immigration increases, support for welfare

payments erodes among natives (Magni 2021, Alesina and Stantcheva 2020; Rodriguez-Justicia and Theilen 2021).

These dynamics matter for immigrant workers, too. When immigrant communities reach a certain size, they are able to form enclaves that offer an enhanced fallback position (Patel and Vella 2013). As a result, it may be that increasing numbers of migrant workers leads to a strengthening of community ties and a stronger fallback position among those workers that fails to analogously materialize among native workers. This can be important both for establishing direct support for workers in the event of unemployment and for creating employment networks.

The importance of networks in matching workers and employers is well-established (Borjas 1992; Bewley 1999; Elliott 1999; Munshi 2003; Ioannides and Datcher Loury 2004; Hellerstein, McInerney, and Neumark 2011). Perhaps unsurprisingly, though, the use of networks varies considerably among different groups and are more important for low-wage workers, especially among Hispanics (Cobb 2009; Hellerstein, McInerney, and Neumark 2011; Pisani 2012). However, Elliott (1999) found that the use of informal networks among less educated workers leads to lower wages, suggesting that these alternatives should be modeled through the fallback position. While immigrant workers who cluster in a local labor market with a high proportion of other immigrants can earn a premium, this may simply reflect the market power of the network and reflect greater bargaining power with employers (Patel and Vella 2013).

To demonstrate the interactions between the community and labor empowerment aspects of immigration aversion, we model the employment relationship through Nash bargaining. Nash bargaining is typically used to study how unions and institutions of collective bargaining affect incentives when workers can undertake some form of collective bargaining<sup>4</sup>. We appropriate this method because it distills two key features of an employment relationship in a labor market where power is a key feature in determining compensation. First, compensation depends upon workers' next best alternatives or their fallback position. In this paper, we model the fallback position of workers as partially dependent on the proportion of migrants in the population. This is meant to capture the idea that workers are dependent on their communities in social support and finding alternative employment. Moreover, it captures the perception that existing social safety nets can become congested, limiting resources in case of unemployment. For the capitalist, the fallback position allows us to examine the role of using migrant workers as a threat to native workers.

Second, compensation in Nash bargaining also depends on each side's bargaining power, which allows either party to capture any gain from the employment relationship above their

<sup>&</sup>lt;sup>4</sup> Recent examples include Skillman (2022), Meccheri and Fanti (2018), Merkl and Schmitz (2011), Upman and Muller (2014)

fallback positions. In the context of labor, the interpretation of bargaining power extends to institutional realities such as the existence of unions or favorable labor laws (Dittrich and Stadter 2015). In our framework, workers are divided into subgroups that bargain collectively. This suggests, in part, that the different worker types (migrant and native) operate under different institutional environments. Thus, bargaining power in this paper is meant to capture circumstances that describe the capacity of workers of different communities to advocate vis-à-vis their employers at different points in time.

While not all employment relationships proceed with explicit bargaining over wages, the validity of the Nash solution still stands for two reasons. First, in the Nash bargaining model, bargaining powers reflect not simply the abilities of individual unions but also the institutional environment that dictate the parameters of the employment relationship. Further, unions create externalities for workers outside their shops through lobbying efforts that influence wages and living standards (Masters & Delaney 2017; Green and Amah 2024). Moreover, Cobb-Clark et. al. (1995) show that legalization of undocumented immigrants has positive effects on immigrant wages. We can think of legalization as a form of empowerment that creates a legal environment where immigrant workers can bargain for better wages with their employers. One can then consider any wage contract as a product of these political forces that influence employment relations. As Ewers et al (2021) argue, bargaining power has correlates beyond the immediate employment arrangement. It captures precarity, legal status, and vulnerability that would affect the general working conditions of migrants.

Secondly, we can think of any contract as a way of sharing the gains from production using each partner's assets (for example, labor from the worker and capital from the employer). To get each of them to agree, the resulting rewards must at least satisfy each person's fallback position. To obtain a portion of what is produced above the fallback position, each partner to the contract uses their positions in the market (Chowdhury 2013)<sup>5</sup>, existing laws and customs, and their innate abilities<sup>6</sup>, and even the types of information they possess about the production

<sup>&</sup>lt;sup>5</sup> Chowdhury (2013) models a process where with some probability  $\beta$ , one party can make a take-it-orleave-it offer, and  $1 - \beta$ , the other party can do the same.  $\beta$  is a stand-in for the relative market power that comes from laws and other political considerations. The paper demonstrates that this approximates the Nash solution.

<sup>&</sup>lt;sup>6</sup> An alternative model of the employment contract might be the efficiency-wages. These are offered to workers, in theory so that they exert their best effort in the production process and that they agree to enter the employment contract. The results of efficiency wages often incorporate the fallback position, the disutility of labor, and information on the quality of effort and other transaction costs. As pointed out previously, efficiency wages can also be derived when the wages come from a bargaining process (see e.g. Garino and Martin 2000 and Koskela and Stenbacka 2004). These considerations are beyond the scope of this current version of the model as we wanted to highlight the basic components of the employment relationship and its interaction with the proportion of migrants.

process. While productivity and ability are determinants of wages, equally important are the resources that determine the power of workers in society (Kollmeyer 2017).

## **3** The Model

Consider an area or industry with two types of workers, natives (n) and immigrants (m), both of whom are seeking work with a single capitalist<sup>7</sup>. The worker groups differ in two ways. First, they differ in a measure of political power  $\beta_i \in (0,1)$  where  $i \in \{n, m\}$  is an index indicating the type of worker. Second, every worker in each group has a fallback position. Specifically, the fallback position of natives is  $z_n(p_m) = v_n + (1 - p_m)$  while for migrants,  $z_m(p_m) =$  $v_m + p_m^8$ . Here  $0 \le p_m \le 1$  is the proportion of immigrants in the population and  $v_i > 0$  is some base parameter for each worker group's fallback position. Thus,  $z_n(p_m)$  falls with the proportion of migrants, and  $z_m(p_m)$  rises with more migrants. This suggests that the perceived value of outside options available to either worker type varies favorably with more of their own community in the population. By specifying the fallback position in this way, we capture the idea that each group sees their own community as both an economic benefit and social support. We can think about  $v_i$  as the portion of the fallback position that is not sensitive to demographic shifts. We assume that  $v_n > v_m$  and  $v_n - v_m > 1$  so that that the native workers have a significantly better fallback position than the migrant workers. The capitalist seeks to hire workers to produce output via the production function  $f(l) = K\sqrt{l}$ , where K is a scaling parameter, and  $K > 1 + v_n + v_m^9$ .

The bargaining problem between the capitalist and workers of type i is summarized as follows:

$$\max_{W_i} \Omega_i = (f(l) - W_i - \varphi_{ki})^{(1-\beta_i)} (W_i - z_i(p_m)l)^{\beta_i}$$
(1)

<sup>&</sup>lt;sup>7</sup> We can think of this single capitalist as a large employer in a company town like a factory or mine. This assumption is reasonable due to evidence of prevailing monopsony power in labor markets from, for example Yeh et al. (2022) and Manning (2021). Manning (2021) is notable for our work as they also argue that in a monopsonistic labor market, institutional factors are key to securing better wages and working conditions for migrants.

<sup>&</sup>lt;sup>8</sup> More complex specifications for  $z_i(p_m)$  are possible. This specification simplifies the exposition. We can think of the portions of the fallback position which  $p_m$  affects as partially politically determined if politicians can heighten the perception that migrants reduce additional increments to natives' fallback position.

<sup>&</sup>lt;sup>9</sup> This assumption on K ensures that workers would produce more than their combined next best alternatives and that the decision to seek employment is rational. K here could change in different points in time depending on, say, the demand for the capitalist's goods, prices, dependence on imports, etc. For the purposes of this paper, a static K could be taken as the circumstances of production at a given point in time.

where  $\varphi_{ki}$  is the capitalist's fallback position when bargaining with worker of type *i*. The way to interpret  $\Omega_i$  is the following: the bargaining between workers and capitalists happens in an environment defined by the contracting institutions, laws, and legal frameworks that assign weight to the worker ( $\beta_i$ ) and the capitalist  $(1 - \beta_i)$ . Here,  $0 < \beta_i < 1$  means that equation (1) represents an asymmetric bargaining environment. If  $\beta_i < \frac{1}{2}$ , then the institutions favor employers over type-*i* workers. We can think of  $(f(l) - W_i - \pi_{kj})$  as the economic profit of the capitalist while  $(W_i - z_i(p_m)l)$  is the economic profit of all type-*i* workers employed. Thus, the collective bargaining process specifies  $W_i$  or the total "wage bill" that the employer pays <sup>10</sup>. This means that for the deal to be worth it or "rational" to either party, it must at least cover each worker's next best alternatives and the capitalist's as well<sup>11</sup>.

The game proceeds as follows:

- (i) The capitalist chooses how much labor to hire;
- (ii) The capitalist bargains with native workers;
- (iii) If bargaining breaks down with native workers, the capitalist turns to migrant workers.

We shall solve this game via *backward-induction*. That is, we first obtain the capitalist's payoff from bargaining with migrant workers ( $\pi_{km}$ ). Anticipating this outcome, he uses this payoff as a threat to the native workers bargaining for the wage bill,  $W_n$ . The capitalist then uses the anticipated outcome of these negotiations to determine how many workers to hire (l). Once the bargaining problem is solved, we analyze  $W_n$  to see how native workers might react to migrants.

Now, since the capitalist cannot use another worker group to threaten migrant workers, then, let  $\varphi_{km} = 0$ . Denote the capitalist's payoff from bargaining with the migrant workers as  $\pi_{km}$ . Since hiring migrants is the capitalist's threat to native workers, then  $\varphi_{kn} = \pi_{km}$ . This specification effectively suggests that any native worker can be replaced by a migrant worker. We use this specification to mimic the sentiment of groups that perceive immigrants as an absolute economic threat in the sense that migrants "take our jobs" ensuring that the threat of replacement is salient to every native worker. We can then derive the following lemmas (For ease of exposition, we have put the proofs for the Lemmas, Corollaries, and the main Proposition in the Appendix):

<sup>&</sup>lt;sup>10</sup> This specification is common in applications of the Nash bargaining model to the collective bargaining problem (see e.g. Cheron Langot 2004, Amegashie 2004).

<sup>&</sup>lt;sup>11</sup> If any one of the economic-profit terms are zero, then the value of the relationship,  $\Omega_i$ , is zero. Thus, the deal between capitalist and worker only has value insofar as both can gain something. Other specifications may be relevant here such as the shape of utility functions with respect to income. However, we opted to simply identify the gains from income in order highlight the dynamics in the employment relationship and how it interacts with the political power of workers and the proportion of migrants.

Lemma 1: The capitalist's payoff bargaining with migrant workers is

$$\pi_{km} = (1 - \beta_m)(f(l) - z_m(p_m)l)$$

Lemma 2: The resulting payoffs from bargaining with native workers are:

For the capitalist: 
$$\pi_{kn} = \pi_{km} + (1 - \beta_n)(f(l) - z_n(p_m)l - \pi_{km})$$
  
The wage bill:  $W_n = z_n(p_m)l + \beta_i(f(l) - z_n(p_m)l - \pi_{km})$ 

The payoffs in Lemmas 1 and 2 suggest that the rewards from bargaining should at least be equivalent to each party's fallback position. In addition, the surplus or the increment that they get of whatever is produced above the combined fallback positions  $(f(l) - z_i(p_m)l - \varphi_{ki})$  depends in part on their political power captured by the parameter  $\beta_i$ . Lemma 2 (i) gives the capitalist's profit function which they will solve to choose the amount of labor they will hire. In other words:

$$\max_{l} \pi_{km} + (1 - \beta_n)(f(l) - z_n(p_m)l - \pi_{km})$$
(2)

The optimization problem defined in equation (2) yields:

**Lemma 3**: The labor demand for the capitalist is  $l^* = \left(\frac{(1-\beta_n\beta_m)K}{2Z}\right)^2$  where  $Z = (1-\beta_n)z_n(p_m) + \beta_n(1-\beta_m)z_m(p_m).$ 

Given Lemma 3, we are now ready to examine how workers will respond to a rise in the proportion of immigrants through their wages. It is important to note that due to the fallback position in the term Z the proportion of migrants will also affect labor demand. This is because, on the one hand, the capitalist can use more migrants as a threat to native workers. However, more migrants also mean stronger communities, which strengthen their fallback position. Thus, there are competing effects on increasing the proportion of migrants in the population. The following corollary gives a benchmark for determining when more migrants can raise labor demand.

**Corollary 1:** 
$$\frac{dl^*}{dp_m} > 0$$
 when  $\beta_n < \frac{1}{2-\beta_m}$ .

Corollary 1 suggests that the effects of immigration on labor demand are linked to the bargaining power of the different worker groups. Consider for instance the situation where  $\beta_m = 0.5$ , while  $\beta_n = 0.75$ . In this case, the increasing proportion of migrant workers would

not raise  $l^*$  since native workers would still command much of the total surplus  $(f(l) - z_i(p_m)l - \varphi_{ki})$ . However, if  $\beta_n = 0.55$ , then, a rise in the proportion of migrants means an increase in labor demand. This is because the capitalists can take advantage of less powerful migrant labor to threaten native workers who fear that a larger portion of immigrants will erode their fallback position and wages. On the other hand, if  $\beta_n > \frac{1}{2-\beta_m}$ , employers will not be able to use the presence of migrants to lower the price of labor. Native workers have high enough bargaining power that they can demand a larger share of the surplus.

From Lemma 2 (ii), following Cheron and Langot (2004) and Amegashie (2004), each worker will receive the individual wage  $(w_n)$  given by:

$$w_n = \frac{w_n}{l} = z_n(p_m) + \frac{\beta_i}{l}(f(l) - z_n(p_m)l - \pi_{km})$$
(3)

Equation (3) summarizes a set of immigration's  $(p_m)$  competing effects on the well-being of native workers. On the one hand,  $p_m$  can lower  $w_n$  through reductions in the fallback position. On the other hand,  $p_m$  can increase  $w_n$  by lowering  $\pi_{km}$  or even expanding output via *l*. The magnitude of these effects also depends on each worker group's bargaining power  $(\beta_i)$ . One interesting case that arises from the literature is where labor demand could respond positively to an increase in migrants. Intuitively, we may expect that native workers will welcome migrants if it means increased employment. However, increased labor increases the wage bill through the total surplus, which is offset by reductions in the fallback position and the threat of being replaced by migrants represented by  $\pi_{km}$ . These competing effects imply some uncertainty in immigration aversion which is addressed in the following proposition.

**Proposition:** If  $\beta_m < \frac{1}{2}$ , then there exists a bound  $r^+ \in (0,1)$  such that  $\frac{dw_n}{dp_m} < 0$  for  $\beta_n < r^+$  and  $\frac{dw_n}{dp_m} > 0$  for  $\beta_n > r^+$ . Further, for any  $\beta_n \in (0,1)$  such that  $\frac{dw_n}{dp_m} < 0$ , it is also true that  $\frac{dl^*}{dp_m} > 0$ .

Figure 1 shows the basic intuition for the Proposition, where the vertical axis represents the derivative of  $w_n$  with respect to the proportion of migrants  $(\frac{dw_n}{dp_m})$  and the horizontal axis is the bargaining power of natives  $(\beta_n)$ . For the case where  $\beta_m < \frac{1}{2} r^+ \in (0,1)$ , there is a region of aversion and of non-aversion when  $\beta_n < 1$ . This means that it is possible that native workers' bargaining power is so low  $(\beta_n < r^+)$  that the perceived erosion of their fallback position is more salient than the potential gains in employment. However, if native workers are politically powerful enough  $(\beta_n > r^+)$ , the perceived effect of migrants is overshadowed by their ability to capture a larger share of the total surplus.

Figure 1: The behavior of  $\frac{dw_n}{dp_m}$  with respect to the bargaining power of native workers  $\beta_n$ .



Further, when  $r^+ < \beta_n < \frac{1}{2-\beta_m}$ , the intuitive case arises where non-aversion coincides with an expansion of demand for labor. However, a counter-intuitive result is also possible when  $\beta_n > \frac{1}{2-\beta_m}$ . This is because of the competing effects of immigration on  $w_n$ : reductions in the fallback position, reductions in output with reduced labor demand, and reductions in the employer's possible payoff when bargaining with migrants. When  $\frac{dw_n}{dp_m} > 0$ , the native workers may capture a larger share of the surplus with their enhanced bargaining power such that it outweighs the reductions in output and the fallback position. However, as discussed in Corollary 1, this level of native workers to extract a larger share of the surplus may overtake any reductions in cost that might come from using migrant workers as a threat.

The Proposition reconciles recent empirical findings in economics and political science- even if immigration generates growth in output and employment, immigration aversion persists. Much of the explanation so far has been sectoral: different sectors of workers experience increasing immigration differently. In our model, labor demand addresses this since, by Corollary 1, the choice of employment increases with the productivity parameter (K). However, the key factor that tips a native worker's reaction to increasing immigration is their political power. If migrants are used as a cudgel against native workers, and if migrants have

very few rights, then we can expect immigration aversion when native workers' political power is also eroding. The immediate prescription here is that improving labor organization and the bargaining power of workers would more likely reduce immigration aversion. It is also important to note the possibilities that the proposition does not treat. When  $\beta_m > \frac{1}{2}$ , the coincidence of immigration aversion with expanding labor demand is uncertain. It is possible that aversion coincides with a reduction in labor demand, which would be the expected outcome. Furthermore, there is a high enough level of  $\beta_m$  for which any proportion of migrants generates aversion <sup>12</sup>. This is because migrants can command a large enough portion of the gains from production that using them as a credible threat would mean reductions in employment and output as well, which is also discussed in Corollary 1. This outcome, while a theoretical possibility, may not be of much practical or policy interest given the configuration of immigration laws today where migrants have little legal recourse for labor disputes. Should there be an increase in migrant bargaining power, it would entail a different analytical model since the threat of employing them instead of native workers would not be credible.

# 4 Historical Application: The Case of the United States in the 20<sup>th</sup> Century

Our model shows that when workers bargain with employers who use migrants as a threat against native workers, it is possible for economic growth, expansion of labor demand due to the influx of immigrants, and immigration aversion to exist together. The determinants of these are bargaining power and fallback position. If native workers' bargaining power is low enough, they may not be able to gain a greater share of the surplus. This, coupled with the perceived erosion of their fallback position can explain the heightened salience of immigration aversion observed in recent years in many rich countries.

We can illustrate these dynamics by examining the past century of U.S. labor history, though we stress that this is only a single application of our model that can be more generalized. The period after the First World War is an example where there is evidence of immigration aversion and an openness among workers to the narratives endorsed by capitalists demonizing immigrant workers. Importantly, Abramitzky and Boustan (2017) note that negative wage effects on unskilled natives during this period (the end of the Age of Mass Migration) may have been larger at this time than it would be today. This is mostly because the U.S. economy was far more reliant on agriculture and manufacturing where native workers would have been more substitutable.

<sup>&</sup>lt;sup>12</sup> From the proof of the Proposition in the Appendix, the root of  $\frac{dw_n}{dp_m}$  exists only when  $b^2 - 4ac = (1 - \beta_m^2)^2 + 4\beta_m(1 - 2\beta_m) = 1 - 2\beta_m^2 + \beta_m^4 + 4\beta_m^2 - 8\beta_m^3 \ge 0$ . This is true for  $\beta_m < B_0 \approx 0.62171$ 





Source: Grieco et al. (2012).

Between March and August of 1919, labor militancy in the United States greatly increased, with 1,847 strikes across the country (Murray 1955). These and other major labor actions brought about the First Red Scare in which capitalists sought to associate labor activism with Bolshevism and the influence of immigrant workers (Murray 1955). As Pope-Obeda (2019) points out, "throughout the First Red Scare, immigrants were among the most central, and most visible, victims of the zealous crusade to square the perceived growth of radicalism across the United States" (32). Indeed, during this period, the proportion of the population that was foreign-born was relatively high at 13.2% in 1920 (U.S. Census Bureau). In what became known as the Red Summer, 1919 also saw higher levels of African American protests for economic and political equality, a cause that became associated with communism by its detractors (Hodges 2019). Clearly, capitalists realized that the issue of radicalism could be useful in positioning themselves against unions (Murray 1955). They were aided in this by conservative unions who were both racist and attempted to portray themselves as pro-capitalist in order to avoid being labelled as communist sympathizers (Hill 1996; Murray 1955). While the number of large-scale labor actions fell after 1919, nativist sentiment remained strong, with the Immigration Act of 1924 entrenching a system of race-based national quotas that severely restricted new entrants, causing the proportion of the population that was foreign-born to plummet, as shown in Figure 2.





Source: Bureau of Labor Statistics (2023)

Strike actions were on the rise once again after the Second World War, reaching a peak of 470 major work disruptions in 1952 that ultimately involved more than 2.7 million workers, as seen in Figure 3 above. In the postwar environment, native worker bargaining power (at least among native white workers) was relatively high, employment was generally expanding with strong growth, and the proportion of the foreign-born population far lower than it had been in 1919, at just 6.9% in 1950 (Grieco et al. 2012) due to the strict immigration restrictions still in place from the Johnson-Reed Act. Because immigration flows were relatively low during this period, the impact of immigrants on wages and employment would have been negligible.

In the 1980s and 1990s, workers exhibited immigration aversion despite immigration expanding employment. In the 1980s, native worker bargaining power was eroded by factors such as increasing competition from imports, and the number of labor disruptions plummeted from 235 involving more than 1 million workers in 1979 to 40 involving just 118,000 workers in 1988 (Bureau of Labor Statistics). At the same time, the proportion of the population that was foreign-born increased from a low of 4.7% in 1970 to 6.2% in 1980 and 7.9% in 1990, shown in Figure 2 (Grieco et al. 2012). Capitalists, once again, had more alternatives for bargaining. This also coincides with a sharp increase in the proportion of people responding in surveys that immigration levels in the United States should be decreased, from 42% in 1977 to 49% in 1986 to 65% by 1993 (Gallup). In 1995, this number was unchanged (Gallup), despite the beginning of a period of prolonged economic growth and low unemployment.





**Figure 4:** Views on immigration in the United States, 1965-2022; "In your view, should immigration be kept at its present level, increased, or decreased?"

This brief empirical application of the model offers an example of how it may be useful with the implication that it could be used with other country cases. For example, in Western Europe, native worker bargaining power is relatively high, suggesting reduced immigration aversion where worker protections are stronger and relatively small wage and employment effects from increased migration. This comports with results from, for instance, Bächli and Tsankova (2021), who find that in Switzerland, higher levels of native worker bargaining power are associated with less political support for anti-immigrant ballot initiatives between 2000 and 2014. In Western European countries between 1996 and 2010, D'Amuri and Peri (2014) find that countries with stronger labor protections saw reduced labor market disruption from migrant workers. More generally, Foged, Hasager, and Yasenov (2022) find in a meta study of immigration effects on rich countries in Europe, North America, and elsewhere, stronger labor protections are associated with a reduced impact of immigration on wages.

# 5 Conclusions

This paper has introduced a novel approach to considering the seemingly contradictory attitudes of native workers towards immigrants that may or may not comport with economic outcomes. In doing so, it introduces the idea of communities determining the fallback position for workers

Source: Gallup (2023).

and ultimately produces cases where the relative bargaining power of native workers can be compatible with immigration preference or aversion in the face of expanded or diminished employment. In particular, when both immigrant and native workers have little power relative to their employers, native workers are more susceptible to immigration aversion. This can, in turn, help determine the salience of the issue of immigration as a political issue, explaining why anti-immigrant political parties have been relatively successful in many rich countries in recent years. It also suggests that improving labor organization can provide a shield against immigrant aversion.

Our model has three limitations that could prove fruitful in further examining the relationship between immigration aversion and labor-empowerment. First, we conceptualize community as a facet of the workers' fallback positions. However, in a more realistic setting, the value of community may influence more than just income or wages. If so, understanding the conditions under which our conclusions hold would be an avenue for future research. Additionally, industries can be heterogeneous, implying different bargaining powers and labor demand. Such differentiation can mean that some industries are more susceptible to immigration aversion than others.

Future research in this area could also seek to understand more clearly the connection between the mechanisms identified here and voting behavior. Notably, Landesmann and Leitner (2022) find that, in some occupations, migration may directly affect native bargaining power, either positively or negatively, suggesting a further possible extension of our model. Examining differences in these dynamics based on worker skill-level and education and interactions of these elements with characteristics such as skin color may also be a fruitful avenue of future research.

Finally, our model can be introduced into a more complex setting to examine feedback between native workers' preferences and strategies employed by political parties. Our findings would suggest that, when native and migrant workers have little bargaining power, politicians who push anti-immigrant sentiment would succeed in recruiting larger portions of native workers. Further, it would be interesting to see under what circumstances a party that advocates purely for restricting immigration would win against a party that advocates purely for raising workers' bargaining power  $\beta_n$  and  $v_n$  in native workers' fallback position.

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# APPENDIX

**Proof Of Lemma 1& 2:** We use maximize equation (1) with respect to the wage bill. The first order condition for this problem is:

$$\frac{\partial \Omega_{i}}{\partial W_{i}} = \frac{-(1-\beta_{i})(W_{i}-z_{i}(p_{m})l)^{\beta_{i}}}{(f(l)-W_{i}-\varphi_{ki})^{\beta_{i}}} + \frac{\beta_{i}(f(l)-W_{i}-\varphi_{ki})^{(1-\beta_{i})}}{(W_{i}-z_{i}(p_{m})l)^{(1-\beta_{i})}} = 0$$

which we can rearrange as:

$$(1-\beta_i)(W_i-z_i(p_m)l)=\beta_i(f(l)-W_i-\varphi_{ki})$$

Isolating  $W_i$  on the left-hand-side, we obtain the wage bill for LEMMA 2 part (ii):

$$W_i = z_i(p_m)l + \beta_i(f(l) - z_i(p_m)l - \varphi_{ki})$$

The capitalist, in turn, gets what is left after the wage bill is paid or:

$$\pi_{ki} = f(l) - W_i - \varphi_{ki} = f(l) - z_i(p_m)l + \beta_i(f(l) - z_i(p_m)l - \varphi_{ki}) - \varphi_{ki}$$
  
=  $\pi_{ki} + (1 - \beta_i)(f(l) - z_i(p_m)l - \varphi_{ki})$ 

or:

$$\pi_{ki} = \varphi_{ki} + (1 - \beta_i)(f(l) - z_i(p_m)l - \varphi_{ki})$$

Now, plug in  $\varphi_{km} = 0$  into

$$\pi_{km} = \varphi_{km} + (1 - \beta_i)(f(l) - z_i(p_m)l - \varphi_{km}) = (1 - \beta_i)(f(l) - z_i(p_m)l)$$

which is the result for Lemma 1. We can plug-in  $\varphi_{kn} = \pi_{km}$  to  $\pi_{kn}$ 

$$\pi_{kn} = \pi_{km} + (1 - \beta_i)(f(l) - z_i(p_m)l - \pi_{km})$$

yielding Lemma 2 part (i).

**Proof Of Lemma 3**: Using LEMMA 1, the first order condition for equation (2) is:

$$\frac{d\pi_{kn}}{dl} = (1 - \beta_n \beta_m) \frac{df}{dl} - (1 - \beta_n) z_n(p_m) - \beta_n (1 - \beta_m) z_m(p_m) = 0$$

Using the functional form for f(l), and noting that  $\frac{df}{dl} = \frac{K}{2\sqrt{l}}$  we get:

$$\frac{d\pi_{kn}}{dl} = (1 - \beta_n \beta_m) \frac{K}{2\sqrt{l}} - (1 - \beta_n) z_n(p_m) - \beta_n (1 - \beta_m) z_m(p_m) = 0$$

Implying that:

$$(1 - \beta_n \beta_m) \frac{K}{2\sqrt{l}} = (1 - \beta_n) z_n(p_m) + \beta_n (1 - \beta_m) z_m(p_m)$$

Or, using the definition of Z from statement of Lemma 3

$$(1 - \beta_n \beta_m) \frac{K}{2\sqrt{l}} = Z$$

Solving for *l* gives the result.

## **Proof Of Corollary 1:**

Observe that  $\frac{dl^*}{dp_m} = -2\left(\frac{(1-\beta_n\beta_m)K}{2Z^2}\right)^2 \frac{dZ}{dp_m}$  and since  $\frac{dZ}{dp_m} = -(1-\beta_n) + \beta_n(1-\beta_m) < 0$ when  $\beta_n < \frac{1}{2-\beta_m}$  which means  $\frac{dl^*}{dp_m} > 0$  when  $\beta_n < \frac{1}{2-\beta_m}$ .

### **Proof Of Proposition:** We shall prove the main proposition in three parts.

- (1) Establish the condition for  $\frac{dw_n}{dp_m} < 0$  for  $\beta_n \in (0,1)$
- (2) Establish the relationship between  $\frac{dw_n}{dp_m}$  and  $\beta_m$  by showing the existence of a critical value  $r^+$  such that when  $\beta_n < r^+, \frac{dw_n}{dp_m} < 0$ . Here,  $r^+$  comes from a quadratic expression that we shall demonstrate in Part (1).
- shall demonstrate in Part (1). (3) Prove that if  $\beta_m < \frac{1}{2}$ ,  $r^+ \le \frac{1}{2-\beta_m}$

<u>**Part (1)**</u> Deriving the condition for  $\frac{dw_n}{dp_m} < 0$ . By Lemma 2, part (ii),

$$w_n = z_n(p_m) + \frac{\beta_n}{l^*} (f(l^*) - z_n(p_m)l^* - \pi_{km})$$

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By Lemma 1,  $\pi_{km} = (1 - \beta_m)(f(l^*) - z_m(p_m)l^*)$ , and so,  $w_n$  can be expanded to

$$w_n = z_n(p_m) + \frac{\beta_n}{l^*} (f(l^*) - z_n(p_m)l^* - (1 - \beta_m)(f(l^*) - z_m(p_m)l^*))$$

or

$$w_n = z_n(p_m) + \frac{\beta_n}{l^*} (\beta_m f(l^*) - z_n(p_m)l^* + (1 - \beta_m)z_m(p_m)l^*$$
$$w_n = z_n(p_m) + \frac{\beta_n}{l^*} (\beta_m K \sqrt{l^*} - z_n(p_m)l^* + (1 - \beta_m)z_m(p_m)l^*)$$

Distributing  $\frac{1}{l^*}$ 

$$w_n = z_n(p_m) + \beta_n \left( \beta_m \frac{K}{\sqrt{l^*}} - z_n(p_m) + (1 - \beta_m) z_m(p_m) \right)$$

Now, plugging in  $l^*$  from Lemma 3, we get:

$$w_n = z_n(p_m) + \beta_n \left( \frac{2\beta_m Z}{(1 - \beta_n \beta_m)} - z_n(p_m) + (1 - \beta_m) z_m(p_m) \right)$$

Using  $Z = (1 - \beta_n)z_n(p_m) + \beta_n(1 - \beta_m)z_m(p_m)$ ,

$$\begin{split} w(p_m) &= z_n(p_m) \\ &+ \beta_n \left( \frac{2\beta_m ((1 - \beta_n) z_n(p_m) + \beta_n (1 - \beta_m) z_m(p_m))}{(1 - \beta_n \beta_m)} - z_n(p_m) + (1 - \beta_m) z_m(p_m) \right) \end{split}$$

Collecting the coefficients of  $z_n(p_m)$ , and  $z_m(p_m)$  and placing all terms above the common denominator  $(1 - \beta_n \beta_m)$  we obtain:

$$w_n = z_n(p_m) \left( \frac{(1-\beta_n)(1-\beta_n\beta_m) + 2\beta_n\beta_m(1-\beta_m)}{(1-\beta_n\beta_m)} \right) + z_m(p_m)(1-\beta_m) \left( \frac{2\beta_m\beta_n^2 + (1-\beta_n\beta_m)}{(1-\beta_n\beta_m)} \right)$$

Using the definitions of  $z_n(p_m)$ , and  $z_m(p_m)$ ,  $\frac{dz_n}{dp_m} = -1$ , while  $\frac{dz_m}{dp_m} = 1$ . Thus, we obtain:

$$\frac{dw_n}{dp_m} = -\left(\frac{(1-\beta_n)(1-\beta_n\beta_m) + 2\beta_n\beta_m(1-\beta_m)}{(1-\beta_n\beta_m)}\right) + (1-\beta_m)\left(\frac{2\beta_m\beta_n^2 + (1-\beta_n\beta_m)}{(1-\beta_n\beta_m)}\right)(4)$$

Now, rearranging equation (4),  $\frac{dw_n}{dp_m} < 0$  when

$$2(1-\beta_m)\beta_m\beta_n^2 + (1-\beta_m) - (1-\beta_m)\beta_m\beta_n$$
  
<  $(1-\beta_n)(1-\beta_n\beta_m) + 2\beta_n\beta_m(1-\beta_m)$ 

or

$$2\beta_m(1-\beta_m)\beta_n^2 - (1-\beta_m)\beta_m\beta_n + (1-\beta_m) < 1-\beta_n(1-\beta_m)(1+2\beta_m) + \beta_m\beta_n^2$$

Moving terms to the left-hand-side and grouping coefficients of  $\beta_n$ , and  $\beta_n^2$  we can obtain the following quadratic function of  $\beta_n$ :

$$\beta_n^2 (2\beta_m (1 - \beta_m) - \beta_m) + \beta_n \big( (1 - \beta_m) (1 + 2\beta_m) - (1 - \beta_m) \beta_m \big) - \beta_m < 0$$
 (5)

Now,

$$2\beta_m(1-\beta_m) - \beta_m = \beta_m(2(1-\beta_m)-1) = \beta_m(1-2\beta_m), \text{ and } (1-\beta_m)(1+2\beta_m) - (1-\beta_m)\beta_m = (1-\beta_m)(1+2\beta_m-\beta_m) = (1-\beta_m)(1+\beta_m) = (1-\beta_m^2).$$

Thus, the inequality (5) can be written as:

$$a\beta_n^2 + b\beta_n + c < 0 \tag{6}$$

where  $a = \beta_m (1 - 2\beta_m)$ ,  $b = (1 - \beta_m^2)$ , and  $c = -\beta_m$ . Since c < 0, then for some values of  $\beta_n, \frac{dw}{dp_m} < 0$ . Further, if the quadratic in (5) has a root  $r \in (0,1)$ , then, if  $\beta_n < r, \frac{dw}{dp_m} < 0$ .

**Part (2)** To establish the roots, we shall exploit the quadratic equation  $r^{\pm} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ . Using the definitions of *a*, *b*, *c* above, we can get the following roots:

$$r^{+} = \frac{-(1 - \beta_{m}^{2}) + \sqrt{(1 - \beta_{m}^{2})^{2} + 4\beta_{m}^{2}(1 - 2\beta_{m})}}{2\beta_{m}(1 - 2\beta_{m})},$$

$$r^{-} = \frac{-(1 - \beta_{m}^{2}) - \sqrt{(1 - \beta_{m}^{2})^{2} + 4\beta_{m}^{2}(1 - 2\beta_{m})}}{2\beta_{m}(1 - 2\beta_{m})}$$
(7)

Since  $\beta_m < \frac{1}{2}$ , a > 0 both terms of  $r^-$  are negative and thus,  $r^- < 0$  and only  $r^+ > 0$ . Further, since a > 0, c < 0, then  $b^2 - 4ac > 0$ . Thus,  $r^+$  is real-valued. For  $r^+ < 1$ , then

Steps	Explanation
$r^+ = \frac{-b + \sqrt{b^2 - 4ac}}{2a} < 1$	By definition
$-b + \sqrt{b^2 - 4ac} < 2a$	Multiplying both sides by $2a$
$\sqrt{h^2 - 4ac} < 2a + b$	Adding <i>b</i> to both sides
$b^2 - 4ac < 4a^2 + b^2 + 4ab$	Squaring both sides
$0 < 4a^2 + 4ab + 4ac$	Moving all terms to right-hand side and canceling $b^2$
0 < a + b + c	Dividing by both sides by $4a$

Plugging in *a*, *b*, *c*, on the final step, we get

$$0 < \beta_m (1 - 2\beta_m) + (1 - \beta_m^2) - \beta_m = 1 - 3\beta_m^2 = P_1(\beta_m)$$

On the relevant interval  $\beta_m \in (0,1)$ ,  $P_1(\beta_m) > 0$  when  $\beta_m < B_0 \approx 0.5773$ , as illustrated in Figure 5.  $\beta_m < B_0 < \frac{1}{2}$ **Part (3):** Let  $\beta_m < \frac{1}{2}$ . To show that for any  $\beta_n \in (0,1)$  such that  $\frac{dw_n}{dp_m} < 0$ , it is also true that  $\frac{dl^*}{dp_m} > 0$ , it suffices to demonstrate that  $r^+ \leq \frac{1}{2-\beta_m}$ . We proceed as in Part 2:

Steps	Explanation
$r^+ = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \le \frac{1}{2 - \beta_m}$	By definition
$-b + \sqrt{b^2 - 4ac} \le \frac{2a}{2 - \beta_m}$	Multiplying both sides by 2 <i>a</i>
$\sqrt{b^2 - 4ac} < \frac{2a + b(2 - \beta_m)}{2 - \beta_m}$	Adding $b$ to both sides and putting right- hand-side on a common denominator

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$$b^{2} - 4ac < \left(\frac{2a + b(2 - \beta_{m})}{2 - \beta_{m}}\right)^{2}$$
  

$$(b^{2} - 4ac)(2 - \beta_{m})^{2} \le \left(2a + b(2 - \beta_{m})\right)^{2}$$
  

$$b^{2}(2 - \beta_{m})^{2} - 4ac(2 - \beta_{m})^{2}$$
  

$$\leq 4a^{2} + b^{2}(2 - \beta_{m})^{2}$$
  

$$\leq 4a^{2} + b^{2}(2 - \beta_{m})^{2}$$
  

$$\leq 4a^{2} + b^{2}(2 - \beta_{m})^{2}$$
  

$$\leq 4a^{2} + 4ab(2 - \beta_{m}) + 4ac(2 - \beta_{m})^{2}$$
  

$$0 < 4a^{2} + 4ab(2 - \beta_{m}) + 4ac(2 - \beta_{m})^{2}$$
  

$$0 < a + b(2 - \beta_{m}) + c(2 - \beta_{m})^{2}$$
  
Moving all terms to right-hand side and canceling  $b^{2}$   
Dividing by both sides by  $4a$ 

Plugging in *a*, *b*, *c*, we have:

$$0 < \beta_m (1 - 2\beta_m), + (1 - \beta_m^2)(2 - \beta_m) - \beta_m (2 - \beta_m)^2 = P_2(\beta_m)$$

We must find the values of  $\beta_m$  for which the polynomial  $P_2(\beta_m) > 0$ . This is true when  $\beta_m < \frac{1}{2}$ . The graphs of  $P_1(\beta_m)$  and  $P_2(\beta_m)$  on the relevant interval  $\beta_m \in (0,1)$  are included below. (a) on Figure 5, shows  $P_1(\beta_m)$  and (b) shows  $P_2(\beta_m)$ . These substantiate the conclusions of Parts (2) and (3).

Figure 5 The graphs of the polynomials  $P_1(\beta_m)$  given on panel (a) and  $P_2(\beta_m)$  given on panel (b)



Now, by Part (2), when  $\beta_n \leq r^+$ ,  $\frac{dw_n}{dp_m} < 0$ . However, since  $r^+ \leq \frac{1}{2-\beta_m}$ , then by Corollary 1, it is also the case that  $\frac{dl^*}{dp_m} > 0$ .