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Organization of Production and Technology Adoption:
Evidence from Jewish Immigration and the Tailoring Industry in England*

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Abstract

This paper studies how the organization of production shapes the adoption of new technologies. We examine a shift in production organization in English tailoring induced by the arrival of Jewish tailors fleeing pogroms in the Russian Empire between 1881 and 1905. When Jewish immigrant tailors arrived in England, native tailors were mostly self-employed and used sewing machines, introduced in the 1860s, to raise individual productivity. In Russia, where sewing machines were largely unavailable to them, Jewish tailors worked in ready-to-wear production, which involved a modular approach and greater collaboration within workshops. Upon arriving in England, they combined the sewing machines with their organizational practice to introduce the so-called "Jewish task system", which relied on an extensive division of labor and enabled clothing production to scale. Combining original data on production tasks with firm-level data, and using immigrant settlement patterns predating the introduction of the sewing machine as an instrument, we show that immigrant arrivals induced native tailors to reorganize production toward this system, accelerating both the diffusion of the sewing machine and England's transition to mass-produced clothing. Our findings show that organizing production efficiently around a new technology is a prerequisite for its diffusion.

Keywords: organization of production, technology adoption, immigration
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> *"For we have here a new province of production, inhabited by a peculiar people, working under a new system* [...] *On the one side of this line we find the Jewish contractor with his highly organized staff of fixers, basters, fellers, machinists, button-hole hands, and pressers, turning out coats by the score* [...] *whilst on the other side of the boundary we see an army of skilled English tradesmen with regulated pay and restricted hours, working on the old traditional lines of one man one garment."*
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> — Beatrice Potter, 'Tailoring', in Charles Booth (ed.), *Labour and Life of the People*, Vol. I (Potter, 1889, p. 209)

1 Introduction

The diffusion of new inventions is key to aggregate productivity growth, yet it remains unclear why some firms adopt while others lag behind. Realizing the productivity potential of new inventions often requires the introduction of complementary ways of organizing production (Brynjolfsson et al., 2021). The idea that there are gains from organizing production efficiently is fundamental and dates back to Adam Smith's *division of labor* (Smith, 1776). However, little is known about the role of production organization in determining adoption across firms, partly because isolating a causal effect is empirically challenging. Efficient organizational practices typically emerge through trial and error as new inventions are introduced (Juhász et al., 2024), making causality difficult to establish. An ideal experiment would involve a shift in organizational practices for a given invention to isolate the effect of practices on adoption. Furthermore, standard data sources rarely reveal adoption directly, let alone how production is organized.

We overcome these challenges by exploiting the arrival of Jewish immigrant tailors in England between 1881 and 1905 and the shift this induced in the organization of production in English tailoring. Fleeing pogroms in the Russian Empire, Jewish tailors arrived when English tailoring was predominantly small-scale and self-employed (Feldman, 1994), and native tailors were using the sewing machine, introduced in the late 1860s, to raise individual productivity. In Russia, although Jewish tailors had limited access to sewing machines (Rabinowitsch, 1903; Carstensen, 1984), they routinely produced ready-to-wear clothing (Wasserman, 2008), hereafter RTW, in home-based workshops where production was more collaborative and, in some cases, involved multiple workers (Subbotin, 1890). On arrival in England, unable to find employment in native workshops because of discrimination (Feldman, 1994), they established their own workshops, combining the available sewing machines with an extensive division of labor to scale up clothing production. The introduction of this new organizational model by Jewish immigrant tailors in England provides a unique setting to isolate the role of production organization in the adoption of a new invention, the sewing machine. We study how their arrival led native tailors to reorganize production and, in turn, increase their adoption of the sewing machine, accelerating England's transition to mass-produced clothing.

To identify the effect of arrivals on native tailors' adoption of the new organization of production and the sewing machine, we compare changes in adoption across English districts with different inflows of Jewish immigrant tailors. Although the pogroms which drove Jewish tailors out of Russia were exogenous to technological progress in England, an endogeneity concern remains if immigrants disproportionately settled in districts where the sewing machine was already more widely adopted. To address this concern, we use a shift-share instrument following Card (2001), predicting district inflows from 1881 onward using the settlement patterns of Jewish tailors in 1851, a time when the sewing machine was not available in England.

To measure adoption, we construct a novel dataset of production tasks at the individual level using English census records from 1851 to 1911, digitized by the Integrated Census Microdata (I-CeM) project (Higgs and Schurer, 2020). A key feature of these records is that respondents provided descriptions of their occupations, which were then classified at the industry level. Using text analysis, we extract granular information from these descriptions and classify tailors into three categories. The first consists of sewing machinists. The second consists of the specialists, who performed tasks such as basting, pressing, and buttonhole making that, under the new organization of production, were separated into specialized workers rather than carried out by a single tailor. Finally, the third consists of generalists, whose descriptions indicate only the occupation of tailor. We measure the adoption of the sewing machine and the new organization of production using the shares of machinists and specialists among tailors respectively.

We complement our analysis with three additional datasets. First, we use arrival records from the Poor Jews' Temporary Shelter in London (Newman and Smith, 2008) to construct the occupational profiles of Jewish immigrants prior to migration and show that occupations in Russia strongly predict occupations in England. Second, we augment the census records with firm-level data from the British Business Census of Entrepreneurs (Bennett et al., 2017) to examine how the transition to the new organization of production affected firm size in English tailoring. Third, we use individual census addresses matched to the street level by Rhodes (2025) as a proxy for workshop location to test whether the new production methods diffused through direct contact between Jewish immigrant and native tailors or instead through broader within-district forces, especially product-market competition between separate workshops.

We find three key results. First, Jewish immigrant tailors established an organization of production that differed from that of native tailors and proved instrumental in diffusing the sewing machine and transforming the industry. We find that they adopted the machine more widely than natives, were more likely to work as specialists, and operated larger workshops. Their workshops were organized with a greater division of labor that drew on the abundant labor supplied by their own immigrant group. In districts receiving larger immigrant inflows, native tailors increased sewing-machine adoption and their representation in specialist occupations, consistent with a reorganization of production toward the immigrant model. Second, immigrant arrivals moved native tailors away from traditional self-employment and toward larger

workshops, increasing the size of native firms and accelerating the shift from artisanal production to the new production system. Third, this transition had important consequences for native employment. While immigrant arrivals reduced employment among native generalist tailors, they generated positive employment effects for natives in the new specialized jobs that emerged with the new production system.

Approximately 140,000 Jewish immigrants fled the Russian Empire and settled in England between 1881 and 1905 (Godley, 2001). Arrival records from the London shelter indicate that 26% had worked as tailors in the Russian Empire.[1] In the English census, we identify Jewish immigrants as individuals born in the Russian Empire and refer to them hereafter as Russian immigrants.[2] Consistent with their occupations before migration, tailoring became the main source of employment for these immigrants in England, absorbing 27% of the inflow. This amounted to a substantial labor supply shock, equal to 5% of the native tailoring workforce in 1881.

We find that, upon arrival in England, Russian tailors established workshops with a distinct organization of production, combining a greater division of labor with more intensive use of the sewing machine than native tailors. In 1881, 3.4% of Russian tailors worked as sewing machinists and 2.6% as specialists, compared with 2% and 0.7%, respectively, among natives. Russian workshops were larger and less artisanal in organization. Russian workshop owners were less likely to be self-employed than natives. Among workshop owners, 36.5% of Russians employed four or more workers, compared with 17.1% of natives, and the average Russian workshop employed 8.1 workers against 5.9 for native workshops. Russian tailoring was also far more male-dominated, with women accounting for 19% of workers, compared with 43% among natives. Women were employed in Russian workshops mainly as general hands, whereas the machinist and specialist occupations were predominantly male (Feldman, 1994).

Our IV results show that Russian arrivals from 1881 to 1901 induced a substantial reorganization of production and increased sewing-machine adoption among native tailors. A 1 percentage point increase in local Russian tailoring employment increased native specialist employment by about 0.03 percentage points and native machinist employment by about 0.05 percentage points on average. The effects on machinists and specialists were positive in each of the two decades, whereas native generalists expanded in the first decade and contracted in the second. Overall native tailoring employment likewise first grew and then shrank, with the contraction driven by the crowding out of generalists. The results show a consistent rise in machinist and specialist shares among native tailors across both decades, indicating that natives gradually adopted the production organization of Russian workshops and, in turn, expanded

[1] As explained in Section 3.1, shelter records begin only in 1896, when the shelter opened. Even so, relative to census estimates, they capture about 55% of the working-age immigrant inflow from the Russian Empire to England between 1891 and 1901.

[2] While we demonstrate the relevance of our instrument in Section 4, it is worth noting that most Russian tailors in 1851 were likely Jewish. Gartner (1960) shows that over 85% of Russians in England in 1871 were Jewish, and he notes that this was the case for most Russians in England in the mid-19th century.

their use of the machine. A partial-equilibrium counterfactual based on the district-level IV estimates implies that Russian arrivals accounted for 6.7% of the observed increase in the machinist share among native tailors in England between 1881 and 1901. Accounting for Russian tailors themselves, the contribution rises to 13.1% for tailoring across these two groups, indicating that Russian arrivals made a quantitatively meaningful contribution to the diffusion of the sewing machine in England. Accordingly, they were responsible for 9.5% of the observed increase in specialization among native tailors and for 31.8% of the increase in specialization overall.

A potential criticism of these results is that our instrument, based on the 1851 settlement pattern of Russian tailors, might proxy for the geography of native tailoring if the two were closely aligned. In that case, districts with an established English tailoring industry may have been more likely to adopt the sewing machine later for reasons unrelated to Russian arrivals. We show that this is not the case. The district allocation of native tailors in 1851 fails to predict future Russian inflows. Native tailors were concentrated in Manchester and central London, whereas Russian tailors clustered in London's East End and Leeds, where subsequent arrivals also clustered. We also test whether our instrument is correlated with local wealth, since wealth may have influenced either technological progress or demand for clothes. We find no significant correlation, reinforcing the validity of the instrument.

Russian arrivals pushed native tailors away from home-based artisanal self-employment and toward workshop production with more employees. In the first decade, they increased the local number of native employees, modestly raised the number of employers, and reduced self-employment. In the second, by contrast, they crowded out native generalist employees. Using the ratio of employees to employers and the self-employed as a proxy for workshop size, we estimate that a 1 percentage point increase in local Russian tailoring employment raised local native workshop size by 2.4 percent in 1881–1891, but reduced it by 1.5 percent in 1891–1901. As a result, although generalist employees were selected out as specialization deepened in the second decade, it did not fully undo the earlier shift toward larger native workshops. As native tailors did not hire Russian workers because of discrimination (Feldman, 1994), these effects do not reflect native workshops absorbing immigrant labor, but rather native tailors reorganizing production within their workshops.

The transition to the new production system was more favorable to male than to female native tailors. In the first decade, immigrant arrivals increased local employment for both groups, but the effect for men was twice as large. In the second decade, the documented contraction among native generalists was driven entirely by falling female employment, while male employment remained unchanged. As a result, native tailoring became more male-dominated, moving closer to the gendered division of labor found in Russian workshops, where men dominated the specialized occupations of the new production system and women were fewer and concentrated in more general roles.

Although Russian arrivals were concentrated in tailoring rather than in other branches of

clothing, we examine whether the transformation they induced also spilled over into neighbouring industries, namely dressmaking, stay and corset making, and shirt-making and seamstress work. Because production tasks differ in these industries, specialization is not directly comparable to tailoring. We therefore ask whether, in districts exposed to Russian inflows, these industries experienced changes in employment structure and gender composition similar to those observed in tailoring. We find a significant contraction in dressmaking in both decades, suggesting that tailoring capturing a larger share of the clothing market as production standardized. This contraction was driven entirely by the displacement of female self-employed dressmakers, while the second decade also shows a positive effect on employees. This result indicates that Russian arrivals triggered a broader reorganization of clothing production away from female self-employment and toward more standardized production in larger workshops.

What led native tailors to adopt the new organization of production brought by Russian immigrants? We distinguish between two diffusion mechanisms in the literature:[3] learning (Ryan and Gross, 1943; Coleman et al., 1957; Bandiera and Rasul, 2006; Conley and Udry, 2010; Adhvaryu, 2014), either through working in the same workshop or through social contact, and competition (Schmitz, 2005; Bloom et al., 2016), with Russian and native tailors operating in separate workshops and competing in the same local clothing market. To explore these channels, we use individual census addresses matched to the street level by Rhodes (2025). Following historical evidence that tailoring workshops, especially among Russian immigrants, were often located in tailors' homes (Feldman, 1994), we use residential address as a proxy for workshop location and street co-location within districts as a proxy for opportunities for direct contact. Under a strong same-street learning mechanism, natives who adopted the sewing machine and the new organization should be more likely to locate on a street with Russian tailors than non-adopters. We find clear evidence of the opposite: native machinists and specialists were no more likely to be co-located with Russian workers than other native tailors. We document substantial street segregation between Russian and native tailors even in Whitechapel, the district that received 20% of Russian tailoring inflows between 1881 and 1901. The evidence rules out a strong direct-contact mechanism operating through shared workshops or immediate street-level proximity. While it does not exclude broader forms of learning within districts, it points more strongly to competition between Russian and native workshops as the main channel through which Russian arrivals induced native tailors to reorganize production around a more effective use of the new machine.[4]

Our findings underscore that organizing production efficiently around a new technology is a prerequisite for its diffusion. Governments rely on a mix of diffusion policies, combining instruments such as equipment subsidies and tax incentives with measures that strengthen firms' in-

[3]For a review of the literature, see Bryan and Williams (2021).

[4]The Russian workshops were not examples of modern industrial facilities. They were characterized by long working hours and unhygienic environments within the confined living spaces belonging to immigrant households (Feldman, 1994). However, our results demonstrate that they contributed to establishing a more modern production process in the tailoring industry at the time.

ternal capabilities (Hall and Khan, 2003; Andrews et al., 2018; OECD, 2025). Our results suggest that the second margin is especially important. Subsidizing the acquisition of new equipment may be incomplete if firms lack the organizational capacity to use it effectively. Policies such as management training on task allocation between technology and labor or subsidies that offset the costs of reorganizing production may be especially influential in accelerating diffusion.

The contribution of this paper is threefold. First, it relates to the literature emphasizing the need of firms to reorganize production in order to realize the productivity gains from new inventions (David (1990), Milgrom and Roberts (1990), Bresnahan and Trajtenberg (1995), Brynjolfsson and Hitt (2000), Bresnahan et al. (2002), Hall and Khan (2003), Bloom et al. (2019), Giorcelli (2019), Juhász et al. (2024)). Recent work has shown how organizational barriers can impede technology adoption (Atkin et al. (2017), Feigenbaum and Gross (2024)). This paper is, to the best of our knowledge, the first to empirically isolate the role of organization of production as an initial condition that shapes the adoption of new inventions. Using the distinct organization of production of Russian tailors relative to natives, we isolate the role of organization in the adoption of the sewing machine and break the reverse-causality link between new inventions and organizational practices. Moreover, relative to the existing literature, our findings draw on a novel dataset that opens the "black box" of production in unusual detail, revealing the use of the machine at the worker level and the way production was organized around it.

Second, this paper contributes to the literature on the role of incumbents in slowing the diffusion of new technologies by remaining locked into old production methods (Chari and Hopenhayn, 1991; Brezis et al., 1993; Devine, 1983; Atkeson and Kehoe, 2007; Hornbeck et al., 2024). Related work has studied the forces that can move incumbents out of such lock-in and shown that trade-induced competitive pressure can lead them to abandon old practices and adapt to new production methods (Galdón-Sánchez and Schmitz, 2002; Schmitz, 2005). Our work identifies immigration as a force that can move incumbents out of lock-in, with immigrant arrivals intensifying product-market competition and inducing native incumbents to adopt new technologies.

Finally, this paper brings insights from the directed technical change literature to the question of how immigration affects native employment. Recent theoretical (Acemoglu and Restrepo, 2018, 2019) and empirical work (Lin, 2011; Autor et al., 2024) has shown that technological change reshapes the content of work, as old jobs disappear and new ones emerge within production, thereby changing the set of jobs available in the labor market. However, studies showing that immigration can affect the direction of technological change (Andersson et al., 2022; San, 2023; Doran et al., 2024; Lewis, 2011; Hornbeck and Naidu, 2014; Coluccia and Spadavecchia, 2024) have paid less attention to how this channel changes the jobs available to natives and, in turn, native employment. The literature on the effects of immigration on native employment also typically treats the set of jobs for whichimmigrants and natives compete as fixed. Our paper is the first to show that by influencing technological change, immigration can

alter the content of work in the host country and thereby reshape the jobs available to natives, with important implications for native employment in the long run.

The paper is organized as follows. Section 2 describes the historical context and Section 3 the data. Section 4 presents the empirical framework and discusses the identification strategy. Section 5 presents the results. Section 6 explores the underlying mechanism. Section 7 discusses our findings and concludes.

2 Historical Background

2.1 Jewish life in the Russian Empire

Following the partitions of Poland (1772, 1793, and 1795) and the Congress of Vienna (1815), the Russian Empire acquired territories that had been home to the world's largest Jewish community since the 14th century. In 1897, the first census of the Russian Empire recorded approximately 5.2 million Jewish people, the vast majority of whom lived in the Pale of Settlement.[5]

In 1786, Catherine II ordered the newly acquired Jewish population to be incorporated into the Russian system of urban estates, including the artisan/petty-trading and merchant estates. In 1791, she issued the decree generally considered the origin of the Pale of Settlement, restricting Jewish residence and commercial activity to the empire's western territories. This was an area larger than France (Nathans, 2002). After 1825, the Pale consisted of the fifteen western gubernias (provinces) of the Russian Empire, not including the Kingdom of Poland.[6]

Under Nicholas I, the Empire moved towards a more far-reaching attempt to reorganize Jewish society. In 1846, Count Pavel Kiselev's Jewish Committee instituted the *razbor*, or "sorting," which cut a demarcation between "useful" and "not useful" Jews by occupation (Nathans, 2002). Useful occupations included merchants, farmers, and artisans. Jews classified as "not useful" were initially made subject to military conscription at twice the rate of other Jews, but this was subsequently increased, at Nicholas I's behest, to five times the rate. Jews were given five years to prove that they belonged to a "useful" category, creating a strong incentive to acquire or formalize artisan status.

These incentives were reinforced by what Nathans (2002) describes as a policy of selective integration, under which residence rights outside the Pale were extended to groups regarded as especially useful to the Empire. First Guild merchants and their families were granted residence rights in the interior in 1859, followed by university graduates, some military veterans, and then master craftsmen and their apprentices in 1865.

Artisan status therefore offered Jewish workers within the Pale not only protection from the

[5]For a map of the Pale of Settlement, please see Grosfeld et al. (2013).

[6]A large share of the Jews living in the Russian Empire lived in the 10 provinces of Congress Poland. However, Jews faced a different set of legal restrictions and opportunities there. In particular, from 1862 they were emancipated vis-à-vis occupational choice, and the May Laws of 1882 did not apply.

penalties attached to "unproductive" occupations, but also a potential route to legal residence outside the Pale.[7] Together, these incentives reinforced an already substantial concentration of Jewish workers in artisanal occupations. Jews in the Pale of Settlement were disproportionately urban and artisanal: in 1897, 49% lived in towns, compared with 16% of Russians and Latvians (Nathans, 2002). Crafts accounted for roughly 25% of the Jewish labor force, with tailoring and shoemaking among the most common occupations.[8] Among Jewish artisans, 38.7% were tailors (Rubinow, 1907).

2.2 Jewish Tailors in the Pale of Settlement

This system of incentives intensified occupational selection, but Jewish expertise in tailoring predated nineteenth-century Russian policy. The religious prohibition on combining wool and linen, *shatnez*, meant that there had been skilled tailors in every significant Jewish community for centuries (Kershen, 1995a; Rubinow, 1907).

Within the clothing industry, Jewish tailors had been involved in the production of ready-to-wear clothing for generations prior to the pogroms of the late nineteenth century. Wasserman (2008) notes that Jewish tailors in Warsaw were specializing in RTW as early as 1795. Kershen (1995b) records Jewish tailors producing clothing for open markets in medieval southern France and making RTW for the military in eighteenth-century Poland. Within the Pale, while tailoring in Kovno, Grodno, and Ostropol was primarily oriented toward local customers, centers such as Minsk, Vilna, and Zhytomyr produced for wider markets. In Minsk, for example, there were already "more than 100 ready-made clothing shops" in 1887 (Subbotin, 1890).

Within the Pale, restrictions meant that Jewish tailors were largely confined to towns and cities, making direct selling to their peasant customers costly. Artisans could travel to fairs, but this was time consuming. The result was the emergence of middlemen, who placed larger orders for RTW goods. In Vitebsk, for example, Jewish tailors worked mainly for dealers in ready-made clothing (Rubinow, 1907, p. 525). Although the organization of production likely differed from that later introduced by Jewish immigrant tailors in England, production in some centers was already taking place in relatively large, multi-worker workshops. Subbotin (1890) notes that in Vilna some Jewish tailoring workshops employed as many as 20 journeymen.

Wages were low, often hovering near subsistence. Subbotin (1890) reports that tailoring journeymen in Vilna earned around 100–150 roubles per year in 1887. Earnings were lower in the southern centres: artisans earned 52–104 roubles in Berdichev and 52–156 in Zhytomyr. Białystok was an exception, and tailors there could earn as much as 260–312 roubles per year.[9] With

[7] Only a small minority of Jewish artisans were granted these permissions. Of the roughly 5.2 million Jews living in the Russian Empire in 1897, 128,000 were living legally outside the Pale (Nathans, 2002).

[8] This was true to such an extent that it became the driving argument for permitting some Jewish artisans to live in the Russian interior (Nathans, 2002).

[9] These annual figures are approximate where Subbotin reports weekly earnings, and assume continuous employment.

family subsistence estimated at around 300 roubles per year, many tailors could not support their households on their own (Rubinow, 1907). Partly for this reason, Jewish tailoring workshops were typically established in the home, with family members and extended networks forming much of the labor force. This practice traveled with Jewish migrants, and reappeared in tailoring workshops in New York, Montreal, and London (Rubinow, 1907; Potter, 1889; Feldman, 1994).

Jewish tailors in the Pale of Settlement had very limited access to sewing machines before 1904. Relative to wages, prices were prohibitively high: in 1881, a machine could cost as much as a full year's earnings, and credit was not always available. By the early 1900s, the cost was down to 50-60 rubles, but this was still very high. Rabinowitsch (1903) notes that the insolvent buyer could put down 10 rubles, and commit to paying 1 ruble a week, for two years. She calculates this as an interest rate of 104%. Carstensen (1984) notes that, in the records of the Singer sewing machine company in Russia during this period, managers advised that 10 rubles was often an impossibly high down payment, and allowed sellers to take less. A more detailed chronology of the affordability of the sewing machine in America, England, and Russia is provided in Appendix C.

Poor artisans often lacked sufficient capital even to purchase materials for a private order, let alone machinery, and when they borrowed they often did so at usurious rates (Rubinow, 1907). Drawing on fieldwork in Mohilev around 1900–01, Rabinowitsch (1903) described a widespread custom among Jewish craftsmen, especially tailors, in which several masters banded together to rent a common workshop and purchase the new machines at shared expense. She describes these as embryonic *Kommanditgenossenschaften* [limited partnerships]. Rabinowitsch also records an earlier, related example of pooled machine ownership from 1889: "In the town of B., I came to know an association bearing traces of a productive association: it consists of 15 rather poor tailors, who all make garments of one particular kind (peasant clothing) for sale; each works in his own home; they possess two communal sewing machines" (Rabinowitsch, 1903).

2.3 Jewish Migration

Between 1881 and 1882, the first wave of anti-Jewish mob violence (pogroms) broke out. Incidents ranged from disturbances, such as the smashing of windows in Jewish homes, to violent outbursts that included assaults and pillaging of Jewish property (Aronson, 1980). The majority of pogroms took place within the Pale, but there were riots in other parts of the Russian Empire. There were three waves of pogroms. The first occurred between 1881 and 1882, the second between 1903 and 1906, and the third in 1917. Following this outbreak of violence, the May Laws of 1882 were introduced, and prohibited Jews from migrating from urban centres to rural areas within the Pale. They also restricted Jewish involvement in real estate and mortgage

markets.[10] Pogroms and the May Laws triggered a large wave of Jewish emigration, with more than 2 million Jewish people fleeing the Russian Empire between 1881 and 1920.

While the majority of these immigrants moved to the United States, approximately 7% settled in the United Kingdom (Godley, 2001). Most established themselves in England, where our estimates suggest that the number of working-age Russian immigrants (ages 15–65) increased fivefold between 1881 and 1901, by roughly 61,000. Although pogroms continued after 1901, the passage of the Aliens Act in 1905 sharply restricted further inflows from the Russian Empire. Approximately 70% of the immigrants who arrived in England settled in London's East End, particularly in the districts of Whitechapel, Spitalfields, Saint George in the East (now part of the London Borough of Tower Hamlets), and Stepney. This pattern is illustrated clearly for immigrant tailors in Figure 1, which maps inflows of Russian-born workers into tailoring across districts in England between 1881 and 1901.

2.4 Jewish immigrant Tailors in England

Everywhere the Jewish migrants went they revolutionized the clothing industry. This was true in Paris, Helsinki, Montreal, and New York.[11] London was to be no exception. In 1881, when the first wave of Russian migrants disembarked, clothing was the fourth largest sector of employment in England (Figure A.1). It was composed of three main industries: shoemaking, hatmaking, and garment manufacture. Garment manufacture comprised tailors, corset and stay makers, dressmakers, shirtmakers, and seamstresses. On arrival, Russian immigrants were immediately over-represented in tailoring (Figure A.2) - while tailoring accounted for approximately 4.8% of the native labor force in England, it absorbed 27% of the Russian immigrants arriving between 1881 and 1901.

A large market for ready-to-wear clothing had existed in England for roughly half a century before 1881. However, this had yet to develop the distinctive features of what Green (1997) describes as the "Jewish task system", which immigrants from the Russian Empire introduced in their tailoring workshops. Under this system, production tasks were divided among specialized workers, typically including a machine operator, baster, finisher, and presser, who were paid collectively for completing a specified number of garments (Green, 1997; Willett, 1902). Using information from the *Dictionary of Occupational Terms in Great Britain* (Ministry of Labour, 1927), Figure 2 compares this system with the traditional home-based artisanal production common among native tailors. In both systems, production began with the cutter, who cut the garment to the required size. From this point, however, the organization of production differed. In artisanal tailoring, the cutter passed the garment to a tailor, who performed all remaining tasks,

[10] Although initially intended as temporary measures, they were followed by additional discriminatory legislation in subsequent years and they remained in force until 1917.

[11] See Mendelsohn (2015), Green (1997) for Paris and New York, Ekholm (2019) for Helsinki, and Dillon and Godley (2012) for Montreal.

including basting, sewing, pressing, and finishing.[12] In the Jewish task system introduced by Russian workers, these tasks were divided among specialized workers. While native workshops were typically staffed by the main tailor and at most one or two assistants, Russian workshops employed a larger number of specialized workers and operated with a more structured organization of production, under the supervision of a master tailor. Figure 3 compares photographs of native and Russian immigrant workshops in England.

Contemporary observers in several countries attributed this production system to Jewish immigrant tailors from the Russian Empire. Willett (1902) dates its emergence in New York to 1876–82 among Jewish coat makers; the U.S. Industrial Commission attributed major advances in the subdivision of tailoring to Jewish workers (United States Industrial Commission, 1901); and Potter (1889) documented the same highly subdivided organization in London by the late 1880s.[13] In particular, Willett (1902) describes the Jewish workshop as "belonging to a transition stage between the home shop and the modern factory. … To the Jews is to be attributed the introduction into New York of these shops, in which the skilled operator, capable of developing a high degree of speed in his work, held the chief place." The sewing machine was central to this new organizational logic.

The sewing machine was first patented in England by William Thomas in 1841. In the 1860s, Singer opened its first factory near Glasgow, and by 1873 the company was offering sewing machines on installment plans. When the first wave of Russian immigrants arrived in the early 1880s, the weekly rental cost of a sewing machine was 2 shillings and 6 pence, a price that Russian tailoring workshops in London's East End could readily afford (Feldman, 1994). Newly arrived Russian tailors were therefore often able to accumulate enough capital to rent sewing machines and establish their own workshops in their flats (Feldman, 1994). The sewing machine disproportionately increased productivity at one stage of the production process, namely sewing itself. The key innovation of Russian tailors was to isolate this stage, assign it to a dedicated machine operator, and reorganize the surrounding tasks so that the operator could remain continuously productive. If machine sewing becomes much faster than hand sewing, much of the potential productivity gain is lost when the same worker must also stop to baste, finish, press, or perform other tasks. In the "Jewish task system", therefore, the standard division of work among basters, finishers, pressers, and other specialists was not arbitrary, but a complementary organizational practice built around the sewing machine.

[12] Basting: stitching pieces of the garment together in preparation for sewing. Pressing: ironing completed garments to give them a finished appearance.

[13] Booth's *Life and Labour of the People* provides an unusually detailed account of Russian immigrant tailoring workshops in London. Using evidence from 901 Jewish coat-making shops, Potter (1889) documents their internal division of labor. Appendix D presents this evidence alongside the growth of ready-to-wear outlets in England.

3 Data and descriptive statistics

3.1 Data

Our analysis draws on four data sources. We use the Temporary Shelter records to recover immigrants' occupations prior to migration, I-CeM historical census records to construct our novel dataset on production tasks, the British Business Census of Entrepreneurs to identify firms, and geocoded census addresses to recover workers' locations at the street level.

Shelter records. The Poor Jews' Temporary Shelter in London served as a point of first contact and temporary refuge for Jewish immigrants arriving from the Russian Empire between 1896 and 1914. The database contains 59,000 arrival records digitized by Newman and Smith (2008), of which 49,000 fall in the shelter's first decade, 1896–1905. More than 34,000 of these early records report immigrants' occupations in the Russian Empire, likely recorded by clerks to facilitate job placement upon arrival. Relative to estimates from the English census, the shelter records capture about 55% of the working-age (15-65) immigrant inflow from the Russian Empire to England between 1891 and 1901. Although shelter arrivals may have been negatively selected on income, we show in Section 3.2 that the share reporting tailoring as their prior occupation closely matches the share of the immigrant inflow absorbed into tailoring in the English census, suggesting that the shelter records do not disproportionately over-represent tailors.

Task data. The census data from 1851 to 1911, excluding 1871, contain 160 million individual records.[14] Our analysis includes only individuals aged between 15 and 65 years old. A notable feature of the census records is that respondents were asked to describe their occupations, and clerks later used these descriptions to classify workers at the industry level, for example as tailors. When the census records were digitized by the I-CeM project Higgs and Schurer (2020), both the industry classification and the original occupational description were retained for each individual.

Table 1 illustrates the structure of the data. All workers in the example are classified as tailors in the first column. The original census responses shown in the second column, however, reveal a finer level of occupational detail: the first individual worked as a presser, the second as a sewing machinist, and the third as a button-hole maker. Using a text-search algorithm, we extract this granular occupational information from the census responses and use it to reclassify tailors accordingly.[15] We distinguish three groups of tailors: sewing machinists, specialists, and generalists. Specialists are distinct from sewing machinists, and the term describes workers who performed the tasks surrounding the machinist's role in ready-to-wear tailoring, as illustrated in Figure 2. Under this new organization of production, these tasks were divided into

[14] The 1871 census for England and Wales is not included in the I-CeM project.
[15] For details on the data construction process, see Appendix C.

specialized jobs rather than carried out by a single tailor. We classify as specialists individuals whose descriptions indicate that they were basters, fellers, trimmers, button-hole makers, finishers, or pressers. Because cutters also existed under the old production system in a different role, they are not characteristic of the new organization of production, and we therefore do not classify them as specialists in our baseline analysis. We do, however, perform a robustness check in which cutters are categorized as specialists. Finally, generalists are tailoring workers whose census descriptions indicate only the occupation of tailor. We measure adoption of the sewing machine and of the new ready-to-wear organization of production using the shares of machinists and specialists among tailors, respectively. Because this information is extracted from census records that also report country of birth, we can identify whether a tailoring worker was a Russian immigrant or a native.

Firm data. The British Business Census of Entrepreneurs (BBCE), 1851–1911, augments the I-CeM census records with information on individuals' employment status (Bennett et al., 2017). It classifies individuals as self-employed, employers (firm owners with employees), or employees. Direct information on the number of employees working for each employer is available unfortunately only up to 1881. Although this prevents us from observing firm size directly after 1881, the data still allow us to study the firm-size dimension of the reorganization induced by Russian arrivals. In particular, we examine whether Russian arrivals shifted native tailors toward larger workshops between 1881 and 1901 by comparing their local effects on the number of native employees with their effects on the number of native employers and self-employed.

Census addresses. We use the street-level geocoding of individual census addresses constructed by Rhodes (2025). Rhodes links residential addresses from the I-CeM census records to digitized historical street geometries, allowing us to assign workers to streets within districts. We use these data in the mechanism analysis in Section 6, where street co-location serves as a proxy for opportunities for direct contact between native and Russian tailors. Since tailoring workshops were often located in tailors' homes, especially among Russian immigrants (Feldman, 1994), residential address can also serve as a proxy for workshop location, allowing us to examine whether native and Russian tailors worked in the same workshops.

For the street-level mechanism analysis, we focus on the 1891 and 1901 cross-sections, when Russian inflows into tailoring had already been sufficiently large for within-district proximity patterns to be informative. Appendix Table B.1 reports, for these two years, the number of native and Russian tailors, machinists, and specialists in our sample, together with the corresponding street-match rate for each group. A worker is considered matched when the residential address recorded in the I-CeM census can be successfully linked to a historical street geometry. Match rates are broadly balanced between Russian and native tailors, though consistently somewhat higher for natives, at about 50% for Russians and 60% for natives in both census years. Most importantly, within each group, match rates for machinists and specialists are generally close to

those for tailors overall. This suggests that the matching does not selectively capture adopters relative to tailors as a whole, and is therefore unlikely to introduce substantial bias into the adoption patterns observed in the matched sample.

3.2 Immigrants from the Russian Empire in England

Using the shelter records to recover immigrants' occupational distribution before they arrived in England reveals that tailoring was the most common prior occupation, indicating that they brought substantial expertise in the tailoring industry. Table 2 shows that 25% of the arrivals had worked as tailors, while 21% had worked in commercial occupations, the second-largest category after tailoring. This is broadly consistent with the evidence in Grosfeld et al. (2020) based on the 1897 Russian census, which shows that Jews in the Pale of Settlement were concentrated in crafts (25%) and trade-related occupations (36.7%), with tailoring and cobbling the most common occupations within crafts. Relative to that benchmark, however, the shelter arrivals were more heavily skewed toward manufacturing, especially clothing and tailoring, and less toward trade than the Jewish population in the Pale.

In line with the prior tailoring experience recorded in the shelter data, the English census shows that tailoring absorbed 27% of the working-age Russian immigrant inflow between 1881 and 1901, making it the single most important source of employment for the Jewish immigrants in England. This implied a labor supply shock equal to about 5% of the industry's native workforce in 1881. Figure 4 plots the evolution of the Russian Empire-born share among tailoring workers in England. Although some immigrants had already arrived by 1881, when they accounted for about 3% of the tailoring workforce, the main inflow occurred between 1881 and 1901. Over this period, the Russian-born share increased by more than twice as much as it had over the preceding two decades, reaching 10% of the tailoring workforce by 1901.

3.3 A shift in the organization of production

We document clear differences between Russian and native tailors in both the use of the sewing machine and the organization of production. To minimize contamination from the subsequent native response to the main immigration wave, we focus on 1881, and compare native tailors with the Russian tailors already present by that date. Table 3 shows that Russians were more likely to work as sewing machinists, with a share of 3.4% against 2.0% among natives. They were also far more likely to work in the specialist occupations associated with the new ready-to-wear division of labor, with a share of 2.6% compared with just 0.7% among natives. Taken together, the combined machinist-and-specialist share was 6.0% for Russians, more than double the 2.7% observed among natives. Differences in workshop organization were equally sharp. Russian tailors were less likely to be self-employed and more likely to run larger workshops. Among workshop owners, 36.5% of Russians employed four or more workers, compared with

17.1% of natives, and the average Russian workshop employed 8.1 workers against 5.9 for native workshops. Russian tailoring was also much more male-dominated, with women accounting for 19% of workers, compared with 43% among natives.

We track the diffusion of the sewing machine and the new organization of production in Figure 5. Panel A plots the share of sewing machinists among Russian and native tailors. Consistent with the timing of the invention and diffusion of the sewing machine, the machinist share is essentially zero for both groups in 1851 and 1861. Following the opening of Singer's factory and the expansion of machine sales (Godley, 2023), the share rises for both groups between 1861 and 1881, with a larger increase among Russian tailors. During the two main decades of immigrant arrivals, the increase becomes much sharper, especially for Russians. By 1901, the machinist share reached about 14% among Russian tailors, compared with just under 10% among natives. By 1911, after the main immigration wave had ended, the native share slightly exceeded the Russian one, suggesting that the use of the sewing machine eventually diffused broadly throughout English tailoring.

We document a similar timing for specialist occupations in Panel B, our proxy for the new organization of production. Reassuringly, the specialist share is again essentially zero for both groups in 1851 and 1861, before the introduction of the sewing machine, supporting our interpretation that the occupations identified by the text-search algorithm capture tasks associated with the new technology and the organization of production. As with machinists, specialist shares rise more strongly among Russian than among native tailors. By 1901, the specialist share among Russian tailors had risen to slightly above 14%. The native specialist share had risen to 5%, indicating that native tailors were gradually adopting the new organization of production. After 1901, consistent with further adoption of the new Jewish task system of production, the native share continued to increase, although the Russian lead remained substantial through 1911. The evidence therefore suggests that mechanization and specialization spread in tandem throughout the main decades of Russian immigrant arrivals. To identify more directly the role of Russian arrivals in native adoption, we turn in the next sections to variation in inflows across districts.

4 Empirical framework

To estimate the causal effect of Russian immigration on the adoption of the sewing machine and the new organization of production in ready-to-wear tailoring by native tailors, we compare changes in adoption across 554 districts in England relative to each district's inflow of Russian tailors. Specifically, we regress decennial changes in the numbers of native tailors, machinists, specialists, and generalists on the decennial change in the number of Russian tailors in the district. We scale both Russian inflows and native outcome changes by the district's broad native clothing base at the beginning of the decade. In addition to tailors, this includes the other

garment-manufacturing occupations recorded in the census: dressmakers, corset and stay makers, and shirtmakers and seamstresses. The denominator captures the relevant scale of the local economy because adjustment was likely to occur within the wider clothing labor market rather than within narrowly defined tailoring alone, a point we examine further below.[16] It also prevents exposure from being mechanically overstated in districts with very small initial stocks of native tailors. We estimate the specification below separately for the two decades of Russian immigrant arrivals, 1881-1891 and 1891-1901.

$$\frac{\Delta Y_{dt}}{B_{d,t-1}} = \alpha_t + \beta \frac{\Delta R_{dt}}{B_{d,t-1}} + \gamma \Delta X_{dt} + \Delta \varepsilon_{dt} \tag{1}$$

Δ denotes the decennial change, d indexes districts, and t indexes census years. Y_{dt} denotes the native outcome of interest, such as the number of native tailors, machinists, specialists, or generalists in district d in year t. R_{dt} denotes the number of Russian tailors in the district. $B_{d,t-1}$ denotes the district's broad native clothing base at the start of the decade, including tailors, dressmakers, corset and stay makers, and shirtmakers and seamstresses. ΔX_{dt} controls for the change in the average age of workers in the district, as younger workers might be more likely to adopt the new technology. α_t denotes period effects, and $\Delta \varepsilon_{dt}$ is the error term.

To assess the effect on adoption, we compare the response of machinists and specialists to Russian inflows with that of generalists and native tailors overall. We then examine how immigrant arrivals affected the organization of production within native tailoring by focusing on firm size. Because firm size cannot be observed directly after 1881 in the BBCE data, we estimate the same specification using changes in the numbers of employees, employers, and self-employed workers to infer the effect on the scale of native workshops. Finally, we examine other margins of adjustment, including male and female employment, and estimate spillover effects on nearby clothing-manufacturing occupations, which together with tailoring formed the broader local clothing labor market.

Our identification strategy relies on the exogenous allocation of Russian tailoring inflows across districts in England with respect to local adoption of the sewing machine and the organization of production. The pogroms that triggered emigration from the Russian Empire were exogenous to technological change in England. Even so, an endogeneity concern would remain if Russian tailors, recognizing the importance of the sewing machine for scaling up production, selectively settled in districts where adoption was already more advanced. In that case, the OLS estimate of β would be upward biased in regressions that measure the effect of Russian arrivals on the numbers of native machinists and specialists.

[16] We do not include shoe and hat makers because our denominator is intended to capture the local garment-manufacturing labor market in which tailoring skills and production methods were most directly relevant. Shoemaking and hat-making constituted distinct trades with different production processes and occupational skills.

We address this concern with a shift-share instrument in the spirit of Card (2001, 2009). For each of the two decades of Russian arrivals after 1881, the instrument predicts district-level inflows of Russian tailors using the geographic distribution of Russian tailors in 1851. Its relevance rests on the idea that newly arriving Russian tailors tended to settle where earlier Russian tailors had already established themselves, while these historical settlement patterns were unrelated to the diffusion of the sewing machine three decades later (Bartel, 1989; Jaeger, 2007). Its validity, in turn, relies on the exogeneity of the 1851 district shares of Russian tailors (Goldsmith-Pinkham et al., 2020). These shares are drawn from a period before the sewing machine was introduced in England and before substantial differentiation within tailoring had emerged, when production remained relatively homogeneous and the shares of machinists and specialists were near zero (Figure 5). Let ΔR_t denote the national decennial inflow of Russian tailoring immigrants, and let $\lambda_{d,1851}$ denote the share of Russian tailors located in district d in 1851. Multiplying the historical district share by the national inflow yields the predicted number of Russian arrivals in district d in decade t; dividing by the district's broad native clothing base in 1851 expresses that predicted inflow relative to the initial size of the local clothing economy. The instrument is therefore given by:[17]

$$\frac{\lambda_{d,1851} * (\Delta R_t)}{N_{d,1851}} \tag{2}$$

The first-stage results are reported in Appendix Table B.2. The corresponding F-statistics, 177.14 for 1881–1891 and 299.56 for 1891–1901, indicate that the instrument is strong in both periods. Another potential threat to identification with this instrumental-variable strategy would arise if the settlement pattern of Russian tailors in 1851 mirrored the geographical distribution of native tailors in the same year. In that case, the instrument would partly capture districts with a stronger traditional native tailoring base, and these districts may in turn have been more likely to adopt the sewing machine later. This concern is particularly relevant for the regressions on the numbers of machinists and specialists, for which such pre-existing differences would bias the estimate of β upward. We address this issue in Table B.3 in the Appendix by reporting placebo first-stage regressions in which district-level inflows of Russian tailors are predicted using the cross-district shares of native tailoring workers in 1851. The low F-statistics in both decades show that the location of native tailors in 1851 does not predict Russian inflows thirty years later. This is consistent with the historical geography of the trade. In 1851, native tailors

[17] Card (2009) scales the shift-share instrument by regional employment in year $t-1$. This normalization implies a first-stage coefficient of one if new Russian immigrant tailors make the same location choices as incumbent Russian tailors in 1851. Our preferred formulation instead scales by the district's broad native clothing base in 1851, so that the instrument can be written as an interaction between a historical local Russian share and a national inflow shock, in line with recent treatments of shift-share designs (Goldsmith-Pinkham et al., 2020; Borusyak et al., 2022).

were concentrated in Manchester and central London, while Russian tailors were largely based in districts in London's East End and Leeds, where later immigrant tailors also settled between 1881 and 1901, as shown in Figure 1.

5 Results

Our findings show that the arrival of Russian tailors led native tailors to reorganize production and, in turn, accelerated the diffusion of the sewing machine in England. We present the results in the following order. We begin with the employment effects of Russian arrivals on native tailors and with evidence on the reorganization of production, comparing effects across specialists, generalists, and sewing machinists. We then show how these changes translated into greater sewing-machine adoption among natives. Next, we examine the effects on the size of native tailoring workshops and on the gender composition of native tailoring employment. Finally, we turn to spillover effects on other clothing manufacturers.

Organization of production. We present our baseline estimates for native tailoring employment in Table 4. Russian arrivals had strong positive effects on native machinists and specialists in both decades. The IV estimates show that a 1 percentage point increase in Russian tailoring inflows relative to the local clothing-manufacturing base increased native specialist employment by about 0.03 percentage points in both decades, and native machinist employment by about 0.04 percentage points in the first decade and 0.05 percentage points in the second (columns 4 and 6). Native generalists, by contrast, increased by about 0.16 percentage points in the first decade, but were severely crowded out in the second, declining by about 0.35 percentage points.[18] This was reflected in the overall size of local native tailoring employment, which expanded in the first decade but contracted in the second. Overall, these effects led to a consistent decline in the share of generalists and a corresponding increase in the shares of machinists and specialists. This is shown in Appendix Table B.4, which presents results from regressions with changes in the shares of machinists, specialists, and generalists among native tailors as outcomes. Although local native generalists increased in number in the first decade, their share still fell in response to arrivals as the shares of machinists and specialists rose. Focusing on the specialist share (Appendix Table B.4, column 4), which we interpret as capturing adoption of the new organization of production, we find that a 1 percentage point increase in Russian tailoring employment relative to the local clothing-manufacturing base raised the specialist share among native tailors by 14% in the first decade and 11% in the second. The results indicate that Russian

[18]The smaller standard errors in the IV regressions of machinists and specialists relative to OLS reflect the fact that the instrument isolates the component of inflows that is most strongly predicted by historical settlement patterns and, in these data, those districts also happen to be more closely aligned with second-stage outcomes than districts with inflows less strongly predicted by the instrument. As a result, IV is less exposed than OLS to noisier cross-district variation and is therefore more precise. For a detailed discussion please refer to Appendix F.

arrivals shifted native tailors away from generalist employment and toward a more specialized division of labor, consistent with re-organizing production according to the Russian immigrant model.

Sewing machine adoption. The reorganization of production consequently increased the adoption of the sewing machine by native tailors, measured by the share of sewing machinists among them. We find that a one percentage point increase in Russian tailoring employment relative to the local clothing manufacturing base raised local adoption of the sewing machine among native tailors by 4% in the first decade and 7% in the second (Appendix Table B.4, column 2).

To assess the aggregate importance of this effect, Appendix Table B.5 reports a back of the envelope national counterfactual, which combines the district-level IV employment effects for native machinists and native tailors from Table 4 with the realized distribution of Russian inflows across districts. In practice, the exercise applies the estimated district-level effects to actual Russian arrivals in each district, uses these to construct the implied counterfactual path of the native machinist share absent Russian inflows, and then aggregates the resulting differences to the national level. The comparison between the observed national machinist share and this counterfactual should therefore be interpreted as a partial-equilibrium lower bound, since it captures direct local exposure but not wider diffusion beyond the districts that received Russian tailors. The estimates show that Russian arrivals accounted for 19.4% of the observed rise in the native machinist share in 1881–1891 and 5.4% of the rise in 1891–1901, making a significant contribution to the diffusion of the sewing machine in both decades (Appendix Table B.5, Panel A). While the local effect on adoption was stronger in the second decade than in the first, inflows in the second decade explain a smaller share of the aggregate increase in that period because the overall diffusion of the machine was broader. Accounting also for machinists among Russian tailors themselves, the contribution rises to 46.1% of the observed increase in the machinist share of both native and Russian tailors combined in 1881–1891 and 8.2% in 1891–1901 (Appendix Table B.5 Panel B).

The same counterfactual exercise shows that Russian arrivals also accounted for 15.9% of the observed rise in the native specialist share in 1881–1891 and 7.72% in 1891–1901 (Appendix Table B.6, Panel A). Once Russian tailors themselves are also included in the counterfactual, the contribution rises to 45.8% of the observed increase in the specialist share in both groups in 1881–1891 and 27% in 1891–1901 (Appendix Table B.6, Panel B).

Size of tailoring firm. Table 5 presents the IV effects of Russian arrivals on native tailors by employment status in columns 1-3. We compare the effects on the number of employees relative to the effects on employers and self-employed to infer the impact on the size of local tailoring firm. In the first decade, a 1 percentage point increase in the inflow of Russian workers into tailoring relative to clothing employment at the baseline, led to about a 0.26 percent increase in native employees, a 0.02 percent increase in native employers and a 0.05 percent decrease in

native self-employed tailors. Using the ratio of the number of employees over employers and self-employed as a proxy for the size of the native tailoring workshop, we find that the same inflow increased local average native workshop size by 2.4 percent. In the second decade, in which we documented a displacement of native generalists earlier, we find that this was driven by a 0.26 percent decline in native tailoring employment among employees, with a milder reduction in self-employment and no effect on employers. The estimates imply that Russian arrivals pushed native tailoring toward larger workshops, consistent with adoption of the new organization of production, although part of this effect was later unwound as generalist native workers exited in the second decade. We interpret this pattern as consistent with a reorganization of production around greater specialization, in which workshop growth became less dependent on retaining generalist labor and more on reallocating work toward specialized tasks.

Gender. Russian tailoring workshops were more male dominated than native ones. We now ask whether adoption of the same organization of production by native tailors altered the gender composition of native tailoring. Columns (4) and (5) of Table 5 report the effects of Russian arrivals on native male and female employment. In the first decade, employment rose for both men and women, but the effect for men was about twice as large. A 1 percentage point increase in the inflow of Russian workers into tailoring relative to baseline clothing employment increased native male employment by about 0.15 percentage points and native female employment by about 0.08 percentage points. In the second decade, by contrast, the displacement of native generalist employees documented earlier was entirely driven by women, whose employment fell by about 0.28 percentage points in response to an inflow of the same size, with no corresponding effect on male employment. Russian arrivals shifted the gender composition of local native tailoring employment toward men, in the first decade because male employment expanded more than female employment, and in the second because female generalist employment contracted.

Appendix Table B.7 analyzes the effects on gender composition by machinists, specialists, and generalists, and shows that this reallocation was task-specific. Although machinist and specialist jobs in Russian workshops were primarily performed by men and women were restricted to generalist work (Feldman, 1994), we find positive effects in the first decade for both male and female machinists and specialists. At the same time, Russian inflows were also associated with a sizable expansion in male generalist employment, suggesting that the initial response was not limited to the new specialized occupations. In the second decade, however, the positive effects on male machinists and specialists roughly double, while the positive effect on female specialists is reduced by half and the effect on female machinists disappears. Together with the sharp contraction in native female generalists,these results suggest that as native tailors adopted the new organization of production, growth in machinist and specialist occupations indeed became increasingly male-biased, in a pattern closer to that of Russian immigrant workshops.

Spillovers to other garment manufacturers. We now examine whether Russian arrivals generated spillover effects on native employment in the three adjacent garment-manufacturing industries: corset and stay makers, dressmakers, and shirtmakers and seamstresses. Appendix Figure A.3 shows that Russian inflows into these industries were negligible relative to tailoring. We therefore ask whether the reorganization they induced within native tailoring also led to a similar reorganization in nearby clothing trades, pushing England's broader clothing sector toward larger workshops and more standardized production. Since production tasks in these industries differ from those in tailoring, it is not possible to classify workers into machinists and specialists in a way that is comparable to our tailoring measures. We therefore study spillovers through their effects on workshop organization and gender composition.

We begin by presenting the employment effects of Russian arrivals on natives in adjacent clothing industries in Table 6. Russian inflows reduced native employment in nearby clothing trades in both decades, with the contraction driven primarily by dressmakers and, to a lesser extent, by shirtmakers and seamstresses. In 1881–1891, a 1 percentage point increase in Russian tailoring inflows relative to the local clothing base reduced native dressmaker employment by 0.17 percentage points and native shirtmaker and seamstress employment by 0.06 percentage points, with effects of similar magnitude in the second decade. We find no effects on the employment of corset and stay makers in either of the two decades.

The contraction in local dressmaking was driven in both decades by the displacement of self-employed manufacturers in response to Russian arrivals. Table 7 shows that a 1 percentage point inflow relative to the local clothing base reduced native self-employment in the first decade by 0.10 percentage points and native employees by 0.06 percentage points. In the second decade, the negative effect on self-employment was more than twice as large, with the same inflow reducing native self-employment among dressmakers by 0.25 percentage points, while increasing wage employment, as measured by the number of native employees, by 0.09 percentage points. As a result, despite driving a contraction in this adjacent industry, Russian arrivals pushed the surviving local dressmakers away from artisanal self-employment and toward larger workshops, in line with the pattern observed in native tailoring. The effects on gender composition also follow a similar pattern to that observed in tailoring (Table 7, columns 4–5). Although Russian arrivals did not increase employment for either male or female dressmakers, the displacement effect fell almost entirely on women, whose local employment declined by about 0.15 percentage points in both decades, shifting the gender composition of native dressmaking toward men. Appendix Tables B.8 and B.9 report the corresponding results for corset and stay makers and for shirtmakers and seamstresses. There, we find only a first-decade decline in female native employees among shirtmakers and seamstresses, and no meaningful effects among corset and stay makers.

Overall, the results suggest negative spillover effects of Russian arrivals on adjacent clothing trades. One possible interpretation is that the reorganization of tailoring production induced

by Russian arrivals allowed tailoring workshops to standardize some garments previously produced in nearby clothing trades, thereby reducing demand for adjacent native manufacturers. These effects were selective rather than broad-based, concentrated in dressmaking and, to a lesser extent, among shirtmakers and seamstresses. Russian arrivals pushed local dressmaking away from small-scale female self-employment and toward larger workshops with more wage workers, consistent with a more standardized organization of production, similar to that observed in native tailoring.

Robustness checks. We now present a series of checks to assess the robustness of our findings. In particular, we show that the results are robust to the possibility that Russian immigrant tailors sorted into poorer districts, where demand for cheaper clothing may have been higher, to the possibility that reorganization was driven by demand from newly arrived Russian immigrants themselves, to alternative definitions of specialist occupations within tailoring, and to the inclusion of controls for district wealth, which may be correlated with technological progress.

Demand for the cheaper standardized clothing produced in Russian workshops may have been higher in poorer English districts. If the Russian tailors present in 1851, on whom our instrument relies, were disproportionately settled in such districts, then the instrument could partly capture differences in local demand rather than historical settlement patterns of Russian immigrant tailors in England. To control for this channel, we proxy for district poverty levels by using the Historical International Standard Classification of Occupation (HISCO), which assigns social status at the individual level based on occupation. We then identify the bottom 10% of occupations in the national social-status distribution and compute, for each district, the share of individuals employed in these occupations. Appendix Table B.10 shows that our results are robust to controlling for this measure in our regressions.

Another potential concern is that the reorganization of production in tailoring was driven not by the Russian tailoring shock itself, but by an increase in local demand for cheaper clothing from arriving Russian immigrants. To assess the plausibility of this demand-side explanation, we compare the presence of Russian immigrants in the local population with their presence in the tailoring workforce. If broader immigrant demand were the primary force behind the observed changes, we would expect Russian immigrants to represent a sufficiently large share of the local consumer base to generate a substantial shift in demand. Appendix Table B.11 reports these shares at the end of each decade of arrivals. Even in high-exposure districts, defined as those in the top quartile of predicted Russian tailoring inflows, the number of Russian immigrants was equal to only 2.3 percent of the native population in 1891 and 5.1 percent in 1901. In contrast, Russian immigrant tailors was 13.13 percent of the number of native tailors in 1891 and 27.43 percent in 1901. Thus, the Russian inflow was much more heavily concentrated within the tailoring workforce than in the local population as a whole. This pattern is difficult to reconcile with an explanation based solely on a broad increase in local demand from Russian immigrants

and instead points to a shock that was disproportionately concentrated on the production side of the tailoring industry. Furthermore, our main results show that native tailors also adopted the new organization of production. The organizational response was therefore not confined to Russian immigrant producers who may have been serving co-ethnic consumers, but diffused to native producers as well. Taken together, these patterns are consistent with a production-side transmission mechanism and weigh against a purely demand-driven interpretation of the results.

We also test the robustness of our results to an alternative definition of specialists. In our baseline analysis, we do not classify cutters as specialists because cutters existed under both the old and new production systems and were therefore not distinctive of the new organization of production. Their appropriate classification is nevertheless ambiguous, and changes in cutter employment during the transition could affect our measure of specialization. Appendix Table B.12 presents a version of our main results in which cutters are classified as specialists. The results are robust to this alternative definition. If anything, the estimated effects on native specialists become slightly larger in both decades relative to our baseline results in Table 4, suggesting that cutter employment also increased with the transition to the new production system.

Finally, district wealth may also confound our estimates, since it may have provided more favorable conditions for technological adaptation. Native tailors in richer districts, with larger urban centres, may have had better access to capital for renting sewing machines and may therefore have adopted the machine more widely independently of Russian arrivals. If Russian immigrant tailors in 1851 were disproportionately settled in such districts, our instrument might partly capture differences in local technological readiness rather than the historical settlement pattern of Russian immigrant tailors in England. To address this concern, we again use the Historical International Standard Classification of Occupation (HISCO). In this case, we identify the top 10% of occupations in the national social-status distribution and compute, for each district, the share of individuals employed in these occupations. Appendix Table B.13 reports the results when controlling for this measure. Our findings are robust to its inclusion. If anything, in the first decade the positive effects on native machinists and specialists remain, while the positive effect on generalists becomes smaller, suggesting that the shift toward the new production system and a greater adoption of the sewing machine was even stronger.

6 Mechanism

This section examines how the new organization of production spread from Russian to native tailors. We distinguish between two diffusion mechanisms. The first is direct learning, either through working in the same workshop or through direct social contact. The second is competition, in which Russian and native tailors operated in separate workshops but competed in

the same district-level market, inducing natives to reorganize production in response. Broader forms of learning within districts, such as learning through observation, need not be separate from competition and may have operated alongside it. We therefore focus on testing for the direct-learning channel. If the evidence rejects that mechanism, we interpret diffusion as operating primarily through competition or other indirect district-level learning forces.

A comprehensive test of whether native and Russian tailors worked in the same workshops would require matched employer-employee data, which are not available for this period. A direct test of learning through social contact would likewise require interpersonal network data of the kind used by Coleman et al. (1957); Bandiera and Rasul (2006); Conley and Udry (2010), which are rarely available in historical settings. We therefore use individual census addresses matched to the street level by Rhodes (2025), and treat residential street co-location as a proxy for opportunities for direct contact between the two groups. This approach also provides an indirect test of whether native and Russian tailors worked in the same workshops, since, as Feldman (1994) notes, tailoring workshops in this period were often located in tailors' homes, making residential address a plausible candidate for workshop location.

We measure street-level segregation by estimating a Duncan dissimilarity index. For native and Russian tailors in our street-matched sample, let native N_s and R_s denote the numbers of native and Russian tailors located on street $s \in \mathcal{S}$. The index is then written as follows.

$$D_{NR} = \frac{1}{2} \sum_{s \in \mathcal{S}} \left| \frac{N_s}{\sum_{s \in \mathcal{S}} N_s} - \frac{R_s}{\sum_{s \in \mathcal{S}} R_s} \right| \tag{3}$$

The index ranges from zero to one. A value of zero implies identical street distributions for the two groups, while a value of one implies complete separation. The index can be interpreted as the share of one group that would need to relocate across streets for its distribution to match that of the other.

We find high levels of street segregation between Russian and native tailors. At the national level, the dissimilarity index is close to 0.9 in both 1891 and 1901. Within the East End of London, which received more than 50% of Russian inflows between 1881 and 1901, the index remains as high as 0.7 (Appendix Figure A.4).[19] Figure 6 visualizes this pattern by classifying East End streets according to the share of Russian tailors among all matched tailors on the street. The map shows that overlap between the two groups existed, but was far from random mixing. Russian tailors were heavily concentrated in the core immigrant districts, especially Whitechapel, where they accounted for more than 50% of tailors on many streets. Moving away from these core areas, Russian shares fell sharply, and many streets contained no Russian tailors at all. Whitechapel, which alone received about 20% of Russian inflows, exhibits the greatest overlap between the two groups and therefore provides the sharpest test of direct learning. Even there, however, segregation remained substantial: about one third of native tailors would have had to

[19] The East End consists of the following districts: Whitechapel, St George In The East, Mile End Old Town, Stepney, Bethnal Green, Shoreditch, and Poplar.

relocate across streets to match the Russian distribution.

Because our baseline adoption results draw on district-level variation in Russian inflows, we test for direct learning within districts. If diffusion operated primarily through close contact, native adopters of the sewing machine and the new organization of production should have been more likely than other native tailors to be located on a street with a Russian tailor. We test this prediction in Whitechapel, the district with the greatest overlap, by comparing the dissimilarity indices of native tailors, native machinists, and native specialists relative to Russian tailors. Since machinists and specialists capture adoption of the sewing machine and of the new production organization, a strong same-street learning mechanism implies that their dissimilarity relative to Russian tailors should be weakly lower than that of native tailors overall.

We present clear evidence against this pattern in Figure 7. In Whitechapel, the dissimilarity indices for native machinists and specialists are not lower than for native tailors overall, indicating that native adopters were no more likely than other native tailors to share streets with Russian tailors. The same conclusion holds in a robustness exercise that repeats the within-district comparison across all English districts with positive Russian inflows, and averages the resulting dissimilarity indices using district population weights (Appendix Figure A.5). Taken together, the spatial evidence points away from a strong direct-learning mechanism operating through close same-street co-location. Furthermore, if residential address is interpreted as a proxy for workshop location, the results support historical accounts that Russian and native tailors worked in separate workshops, with the new organization of production concentrated in the Russian immigrant workshops. The evidence does not rule out broader forms of learning within districts. Natives may still have observed Russian production indirectly or learned about it through wider local networks. However, it points more strongly to competition between Russian and native workshops, rather than direct social contact or same-workshop learning, as the main channel through which Russian arrivals induced native tailors to reorganize production.

7 Discussion and conclusions

In this paper, we study how the organization of production within the firm shapes its capacity to adopt new technologies. Although realizing the productivity gains from new inventions is usually thought to require complementary changes in production organization (Brynjolfsson et al., 2021), there is little evidence on how such organizational choices affect technology diffusion. The empirical challenge is that new technologies and new forms of production organization often emerge together, making it difficult to isolate the role of organization in technology adoption, while standard data rarely reveal both the use of a technology and how production is organized around it.

We address this challenge by exploiting a shift in production organization in the English tailoring industry induced by the arrival of Jewish immigrant tailors from the Russian Empire in

the late nineteenth century. Using newly constructed individual-level data on production tasks from the English censuses, we study how this organizational change affected the diffusion of the sewing machine. Drawing on their experience in clothing workshops with greater collaboration among workers in Russia, immigrant tailors established a production model that combined a greater division of labor with the use of sewing machines to scale up production. This differed sharply from the small-scale, self-employed production of native tailors, who used the sewing machine predominantly to increase individual productivity. Using an IV strategy based on immigrants' settlement patterns prior to the sewing machine's introduction, we study how their arrival led native tailors to adopt the new production organization and, in turn, the sewing machine.

We show that Russian immigrant tailors introduced a distinct production model characterized by a greater division of specialized tasks across workers, larger workshops, and substantially higher use of sewing machines than among native tailors. In districts that received larger inflows of Russian immigrant tailors, natives reorganized production in accordance with the immigrant model. They moved away from traditional self-employment toward larger workshops, increased the division of labor, and adopted sewing machines at higher rates. We provide evidence that points away from direct learning from Russian immigrants and instead suggests that market competition was an important force behind the diffusion of this production system among native tailors. We show that the production system established by Russian immigrants in tailoring also diffused to other clothing trades, including dressmaking and shirtmaking, despite these trades receiving only limited inflows of Russian immigrant workers. The results show that the new organization of production introduced by Russian immigrant tailors accelerated both the diffusion of the sewing machine and the broader transition of the English clothing industry toward standardized production.

Our findings offer important insights for policies aimed at accelerating the diffusion of new technologies, including AI. Economists and policymakers have emphasized that the absence of complementary organizational practices can constitute an important barrier to technology adoption (OECD, 2016; Cirera and Maloney, 2017). Recent evidence from firm surveys similarly identifies organizational readiness (McElheran et al., 2026) and firms' capacity to undertake complementary organizational changes (Bonney et al., 2024) as important determinants of AI adoption. By exploiting the introduction of the distinct production system by Russian immigrant tailors and tracing its effects on the diffusion of the sewing machine, we isolate the role of production organization and show that organizing production efficiently around a new technology is a critical initial condition for its diffusion. Governments often rely on instruments such as equipment subsidies and tax incentives to accelerate technology adoption. Our results suggest that such policies may be insufficient if firms lack the organizational capacity to use new technologies effectively. Policies that strengthen organizational readiness, such as management training on the allocation of tasks between technology and labor or subsidies that offset the costs

of reorganizing production, may therefore play an important role in accelerating diffusion.

Our results further contribute to understanding the forces that can move incumbent firms out of lock-in to established production methods. Despite access to the sewing machine, native tailors initially remained tied to their traditional production method and did not reorganize production around the new technology. It was the arrival of Russian immigrant tailors and the production system they introduced that induced native incumbents to adjust. While earlier work has shown that trade-induced competition can push incumbents out of lock-in (Galdón-Sánchez and Schmitz, 2002; Schmitz, 2005), we identify immigration as another force that can generate such competitive pressure and accelerate technological adaptation.

Finally, we shed new light on the effects of immigration on native employment by accounting for its impact on the direction of technological change. Changes in the direction of technological change reshape the task content of work (Lin, 2011; Acemoglu and Restrepo, 2018, 2019; Autor et al., 2024), and, consequently, the types of jobs available to native workers in the host economy. We find that, while the arrival of Russian immigrant tailors substantially displaced self-employed native tailors working as generalists, it also created new employment opportunities for natives in the specialized jobs that emerged with the new production process. Immigration policies today are often designed around the host country's existing demand for immigrant labor. Our findings suggest that this perspective may be incomplete. The expertise immigrants bring can itself shape the direction of technological change and, in turn, labor demand, with important implications for native employment over the longer run.

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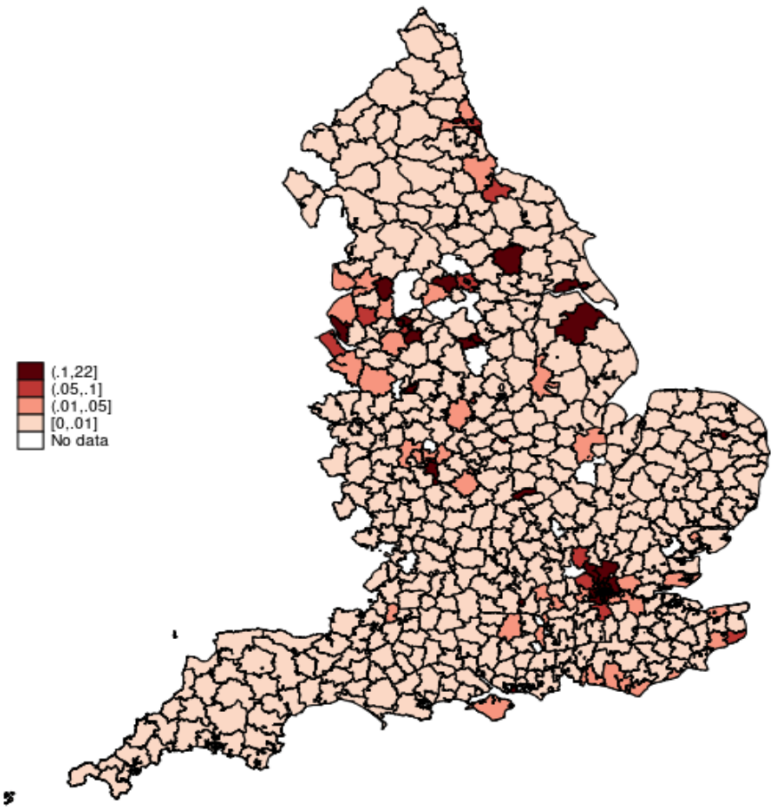
8 FIGURES

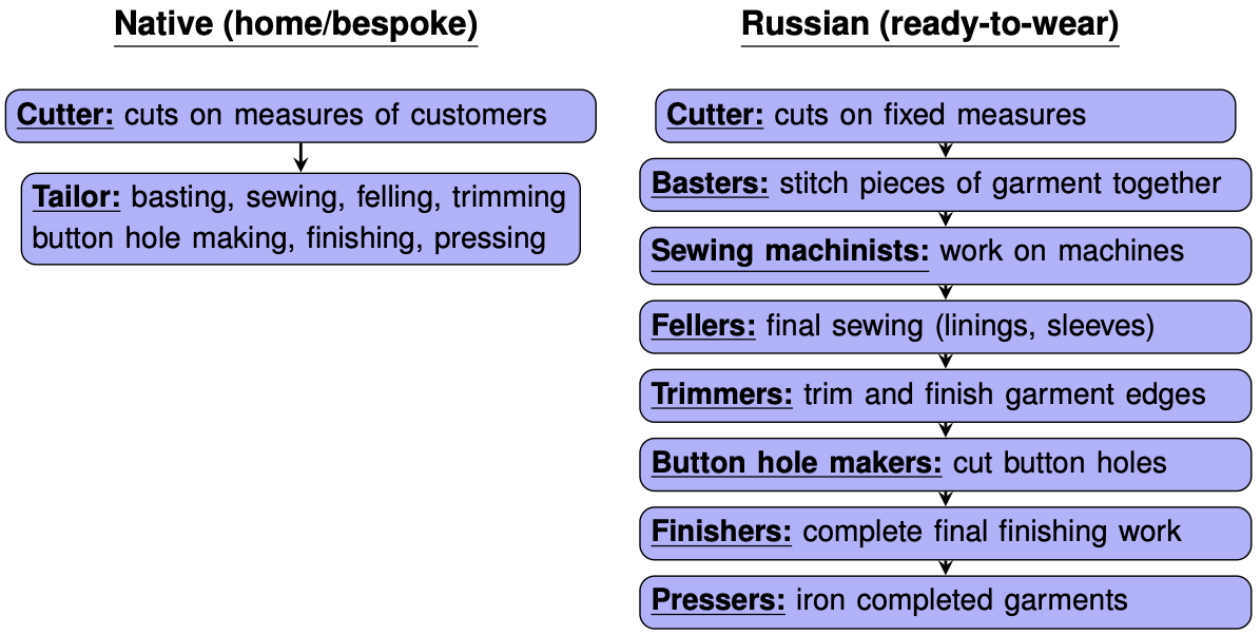
Figure 1: Inflows of Russian-born into tailoring across districts in England, 1881-1901



Whitechapel	20%
St. George East	17%
Stepney	16%
Leeds	12%
Manchester	7%
Westminster	4%
Bethnal Green	3%
Liverpool	3%
Kensington	1%
Birmingham	1%

Source: I-CeM data 1881-1901.
Notes: The map presents the distribution of the inflow of Russian-born workers into tailoring across districts in England between 1881 and 1901. It highlights the variation used to identify the effect on the adoption of the sewing machine and the new organization of production. The table on the right lists the ten districts that absorbed the largest shares of the immigration influx.

Figure 2: Organization of tailoring among native and Russian immigrant tailors



Notes: The figure illustrates the organization of production among native tailors, who concentrated in home and bespoke production, and among Russian immigrant tailors, who concentrated in ready-to-wear tailoring. It shows the contrast between the two systems as described in the *Dictionary of Occupational Terms in Great Britain* (1921). Production starts at the top of each diagram. The process for native tailors is shown on the left and that for Russian immigrant tailors on the right. In both cases, production begins with the cutter. In home and bespoke tailoring, the cutter cuts garments to the specific measurements of each customer, whereas in ready-to-wear tailoring the cutter works with fixed, standardized measurements. The main difference between the two systems is that tasks carried out by a single tailor in home and bespoke production, including basting, sewing, felling, trimming, button hole making, finishing, and pressing, are divided among specialized workers in ready-to-wear production.

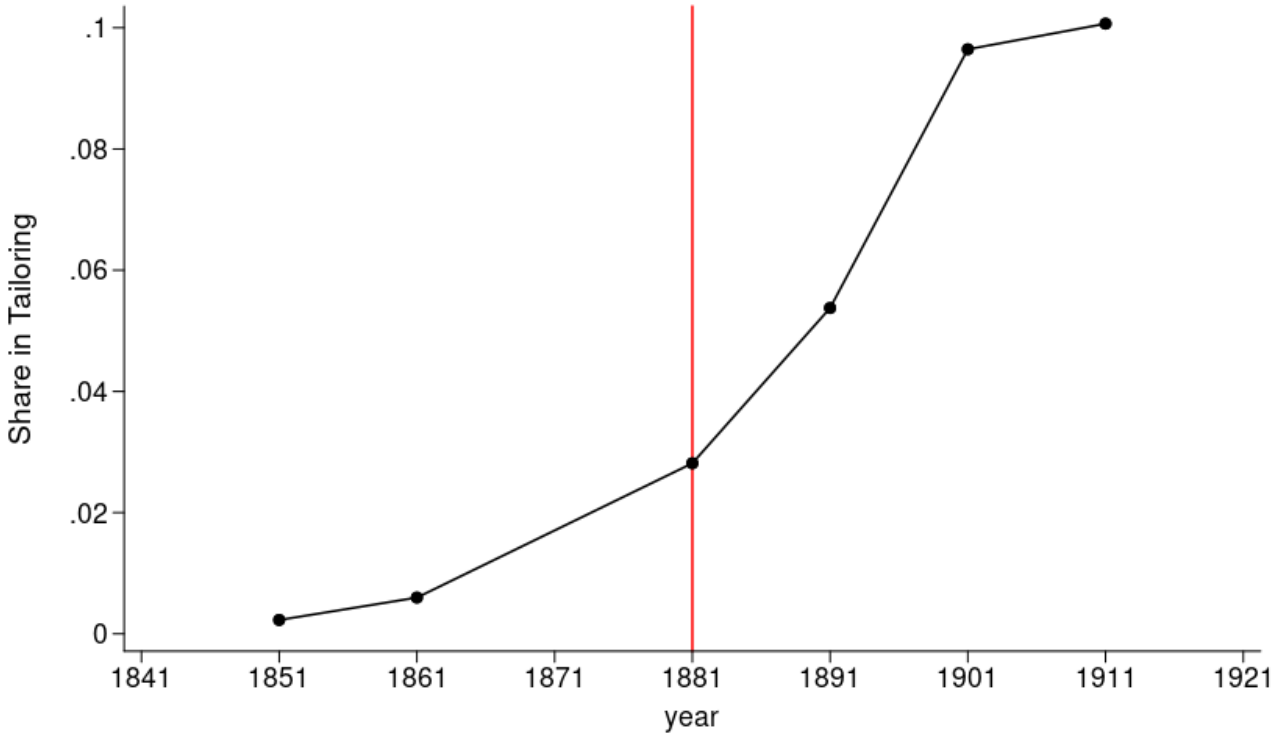
Figure 3: Pictures of workshops of native and Russian immigrant tailors in England

Workshop of native tailor

Workshop of Russian tailor

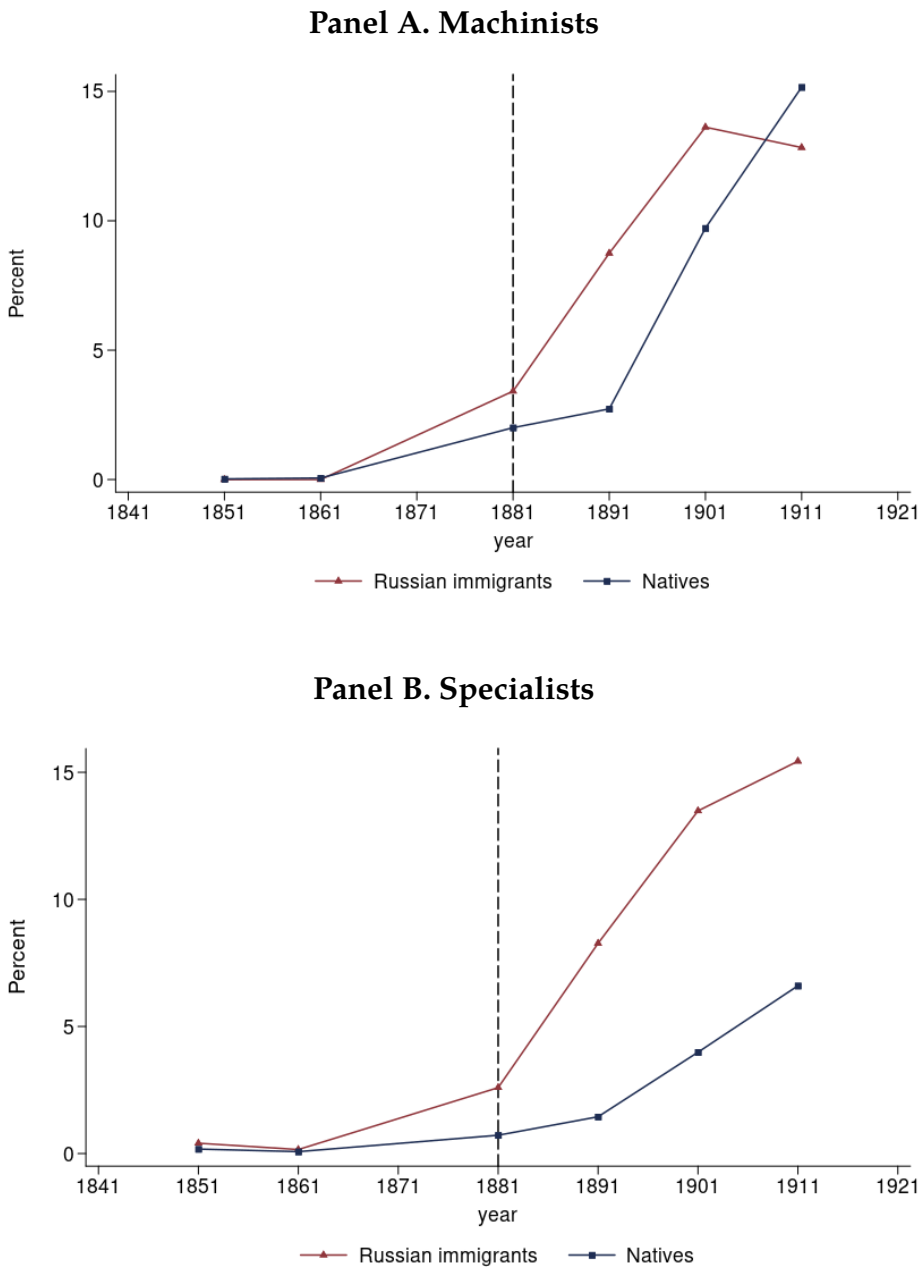
Notes: The picture on the left illustrates a workshop of a native tailor. The picture on the right illustrates the workshop of a Russian immigrant tailor established in the East End of London.

Figure 4: Share of Russian-born among workers in tailoring



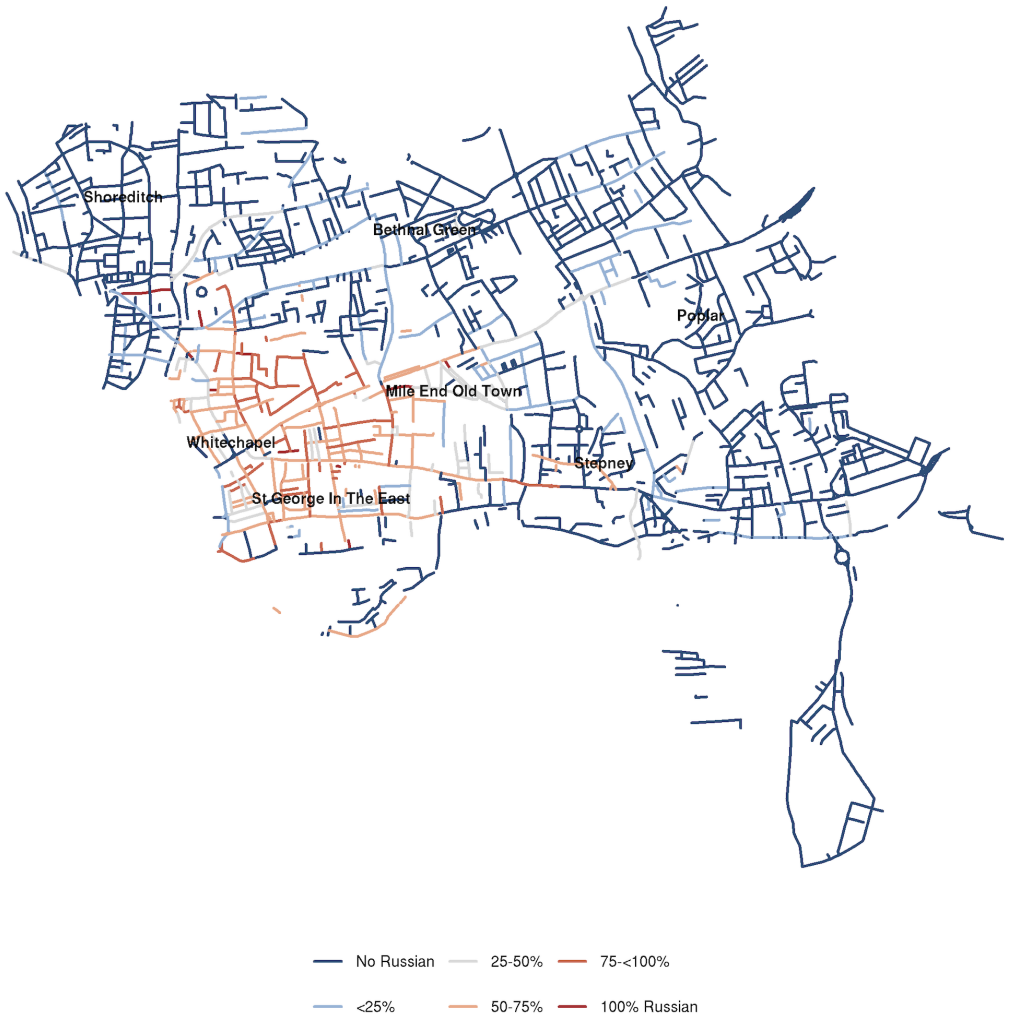
Source: I-CeM data 1851-1911.
Notes: The figure plots the share of Russian-born workers in the tailoring industry in England from 1851 to 1911. We identify an immigrant born in the Russian Empire as an individual born in today's Russia, Latvia, Lithuania, Poland, Belarus, Moldova or Ukraine (Pale of Settlement). We exclude from analysis individuals on British ships in home ports, in the royal navy whether at sea or abroad, on ships at sea or abroad and those on the military abroad.

Figure 5: Shares of granular occupations among tailoring workers



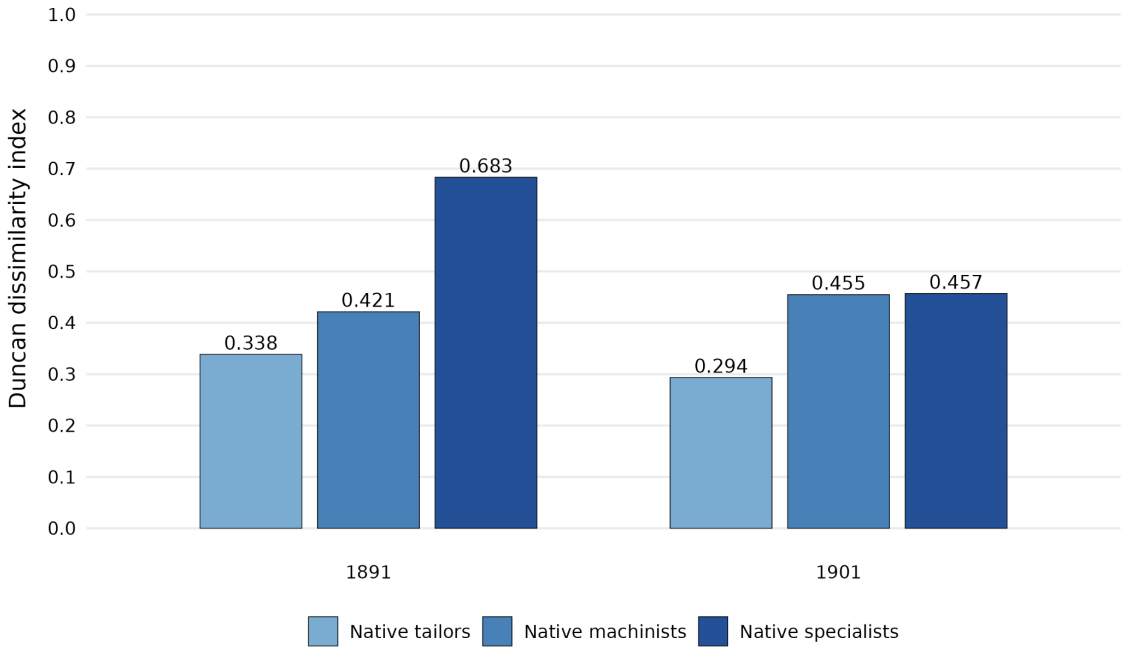
Source: I-CeM data 1851–1911.
Notes: Panel (a) plots the share of machinists among Russian immigrant and native tailoring workers. Panel (b) plots the share of specialists among Russian immigrant and native tailoring workers.

Figure 6: Share of Russian Tailors by Street in the East End, 1891–1901 Pooled



Source: I-CeM data 1891-1901 matched to street geometries by Rhodes (2025).
Notes: Streets are classified by the share of Russian tailors among all matched tailors on the street, pooling 1891 and 1901. Streets are included if they contain at least one matched tailor. The East End consists of Whitechapel, St George In The East, Mile End Old Town, Stepney, Bethnal Green, Shoreditch, and Poplar.

Figure 7: Street-level dissimilarity in Whitechapel



Source: I-CeM data 1891-1901 matched to street geometries by Rhodes (2025).
Notes: The figure reports Duncan dissimilarity indices in Whitechapel between native tailors and Russian tailors, between native machinists and Russian tailors, and between native specialists and Russian tailors, for 1891 and 1901. Streets are included if they contain at least three matched tailors. Higher values indicate greater segregation across streets.

9 TABLES

Table 1: Example Data

Industry Code	Original Census Response	New Variable	Country of Birth
653 (tailor)	tailoring presser	presser	Russian Empire
653 (tailor)	tailoring sewing machinist	machinist	Russian Empire
653 (tailor)	tailoring button hole	button holer	England
653 (tailor)	tailor's baster	baster	Russian Empire
653 (tailor)	tailoring	tailor	England

Notes: This table provides an example of our dataset. All individuals are classified as tailors in the first column. The original census responses in the second column reveal a finer level of occupational detail. The first individual worked as a presser, the second as a sewing machinist, and the third as a button-hole maker. Using a text-search algorithm, we extract this information from the census responses and construct the occupational variable shown in the third column. We use it to classify tailors into three categories: sewing machinists, specialists, and generalists. Specialists are tailoring workers who performed the specialized jobs organized around the role of the sewing machinist in ready-to-wear production, such as basters, fellers, button-hole makers, and pressers. Generalists are tailoring workers whose census descriptions indicate only the occupation of tailor, as in the last row of the table. We use the country-of-birth information shown in the last column to identify whether a worker was an immigrant or a native.

Table 2: Occupation of Russian immigrants prior to arrival in England

Occupational distribution in the Russian Empire	Percent
Agriculture	0.94
Manufacturing	71.29
Clothing	40.13
Tailoring	25.41
Other clothing	14.72
Wood and construction	14.56
Food	5.77
Metals	5.29
Other manufacturing	5.54
Commerce	20.98
laborers and domestic services	2.07
Professionals	2.76
Other	1.94
Observations	34,572

Source: Poor Jews' Temporary Shelter in London Database 1896-1905.
Notes: This table presents the occupational profile of arriving immigrants in the Russian Empire prior to migration to England. The Temporary Shelter in London worked as a point of first contact and temporary refuge for Jewish immigrants arriving from Eastern Europe. More than 34,000 shelter records between 1896 and 1905 report the occupation of arriving immigrants in the Russian Empire. Manufacturing includes clothing, wood and furniture, building and construction, food, metals, and other manufacturing. Clothing includes tailoring, hat-making, boot-making, and other clothing occupations. Other includes conveyance and residual occupations.

Table 3: Characteristics of Russian and native tailors in England, 1881

	Russian tailors	Native tailors
Occupational composition (%)		
Machinist share	3.42	2.00
Specialist share	2.59	0.72
Machinist + specialist share	6.01	2.72
Employment status (%)		
Employees	84.95	80.16
Workshop owners	15.05	19.84
Among workshop owners (%)		
Self-employed	50.00	60.93
Employers with 1–3 employees	13.48	22.00
Employers with 4+ employees	36.52	17.08
Workshop size		
Avg. number of employees	8.08	5.91
Gender		
Female percentage	19.19	43.00
Observations	3,893	116,818

Source: I-CeM data 1881.
Notes: This table compares the characteristics of Russian and native tailors in England in 1881. Occupational, employment-status, and gender entries are reported as shares within the relevant tailoring population. The rows on self-employment and employer size are reported as shares among workshop owners. The workshop-size measure reports the average number of employees per workshop.

Table 4: The impact on native reorganization within tailoring

	Native tailors		Native machinists		Native specialists		Native generalists	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. 1881–1891								
Russian tailor inflows	0.550	0.238***	0.050***	0.043***	0.049***	0.033***	0.451	0.162***
	(0.340)	(0.058)	(0.016)	(0.003)	(0.018)	(0.001)	(0.306)	(0.059)
R^2	0.0266		0.0528		0.1050		0.0201	
KP F-stat		177.14		177.14		177.14		177.14
No. of districts	554	554	554	554	554	554	554	554
Panel B. 1891–1901								
Russian tailor inflows	-0.037	-0.278*	0.063**	0.050***	0.045***	0.028***	-0.144***	-0.356**
	(0.039)	(0.147)	(0.026)	(0.010)	(0.012)	(0.005)	(0.046)	(0.144)
R^2	0.0007		0.0139		0.0379		0.0079	
KP F-stat		299.56		299.56		299.56		299.56
No. of districts	554	554	554	554	554	554	554	554

Notes: The table reports regressions of decennial changes in native tailoring outcomes on decennial changes in Russian immigrants in tailoring, scaled by the lagged broader local native clothing-manufacturing base. All specifications include the decennial change in the average age of workers in the district as a control. Regressions exploit variation across 554 districts in England. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), 1% (***).

Table 5: The impact on native employment structure and gender composition within tailoring

	Employment status			Gender	
	Native employees	Native employers	Native self-employed	Native men	Native women
	(1)	(2)	(3)	(4)	(5)
Panel A. 1881–1891					
Russian tailor inflows	0.262***	0.021***	-0.046***	0.155***	0.082**
	(0.052)	(0.007)	(0.012)	(0.033)	(0.033)
KP F-stat	177.14	177.14	177.14	177.14	177.14
No. of districts	554	554	554	554	554
Panel B. 1891–1901					
Russian tailor inflows	-0.260*	-0.004	-0.014	-0.002	-0.276***
	(0.141)	(0.005)	(0.011)	(0.065)	(0.084)
KP F-stat	299.56	299.56	299.56	299.56	299.56
No. of districts	554	554	554	554	554

Notes: The table reports IV coefficients from regressions of decennial changes in native tailoring outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. All specifications include the decennial change in the average age of workers in the district as a control. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), 1% (***).

Table 6: Spillover effects on native employment across other clothing manufacturers

	Pooled manufacturers (1)	Dressmakers (2)	Corset and stay makers (3)	Shirtmakers and seamstresses (4)
Panel A. 1881–1891				
Russian tailor inflows	-0.244**	-0.170**	-0.011	-0.063**
	(0.100)	(0.077)	(0.011)	(0.027)
KP F-stat	177.14	177.14	177.14	177.14
No. of districts	554	554	554	554
Panel B. 1891–1901				
Russian tailor inflows	-0.224	-0.156	-0.010	-0.058
	(0.150)	(0.124)	(0.007)	(0.037)
KP F-stat	299.56	299.56	299.56	299.56
No. of districts	554	554	554	554

Notes: The table reports IV coefficients from regressions of decennial changes in native workers in adjacent clothing occupations on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. Column (1) reports the pooled adjacent category, while columns (2)–(4) decompose the effect across the three constituent occupations. All specifications include the decennial change in the average age of workers in the district as a control. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), and 1% (***).

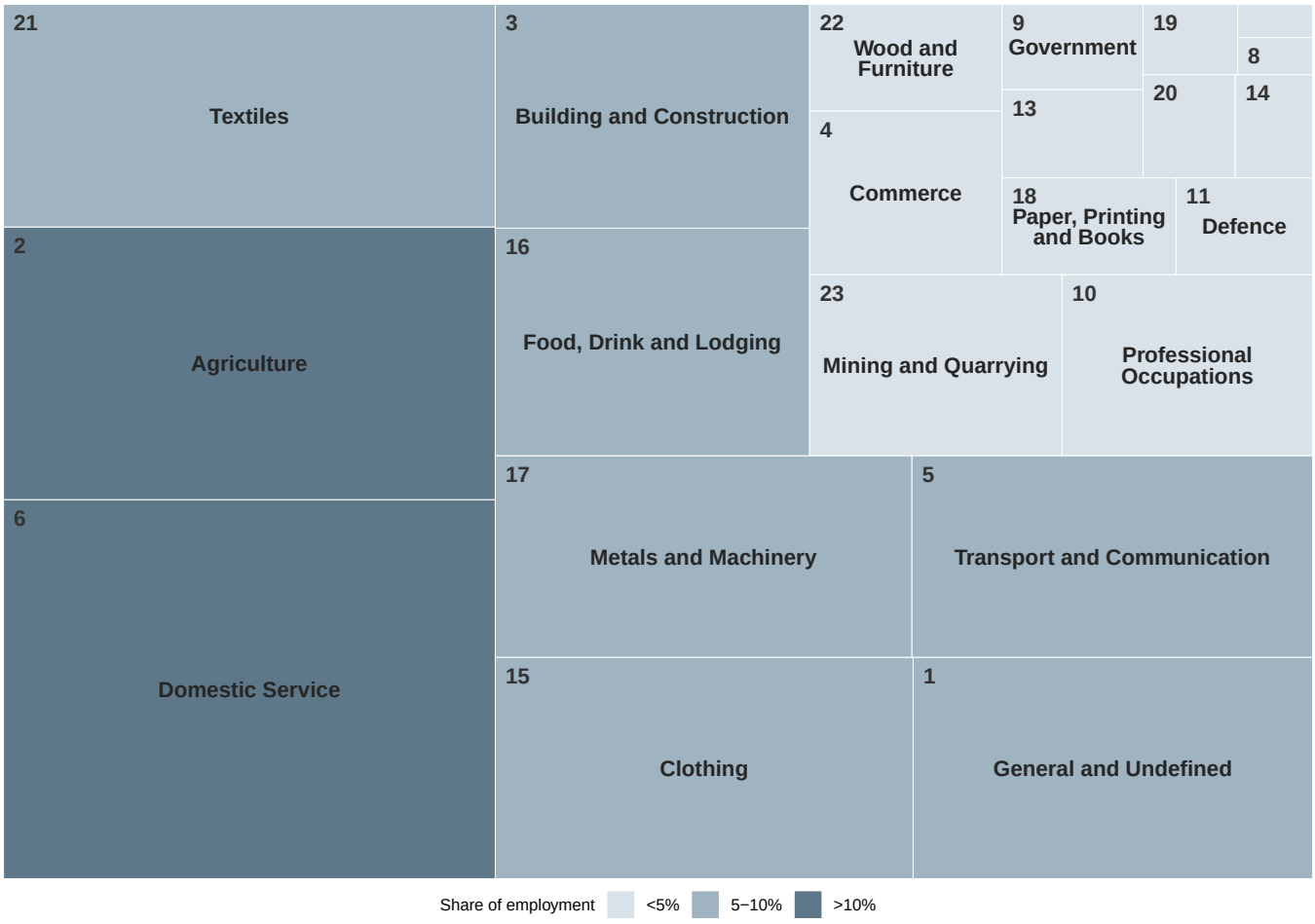
Table 7: Spillover effects on native employment among dressmakers

	Employment status			Gender	
	Native employees	Native employers	Native self-employed	Native men	Native women
	(1)	(2)	(3)	(4)	(5)
Panel A. 1881–1891					
Russian tailor inflows	-0.062*	-0.005	-0.103*	-0.012***	-0.158**
	(0.034)	(0.006)	(0.055)	(0.003)	(0.075)
KP F-stat	177.14	177.14	177.14	177.14	177.14
No. of districts	554	554	554	554	554
Panel B. 1891–1901					
Russian tailor inflows	0.088**	0.015	-0.258*	-0.000	-0.156
	(0.042)	(0.010)	(0.137)	(0.005)	(0.123)
KP F-stat	299.56	299.56	299.56	299.56	299.56
No. of districts	554	554	554	554	554

Notes: The table reports IV coefficients from regressions of decennial changes in native dressmaker outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. The overall effect on native workers in this occupation is reported in Table 6. All specifications include the decennial change in the average age of workers in the district as a control. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), and 1% (***).

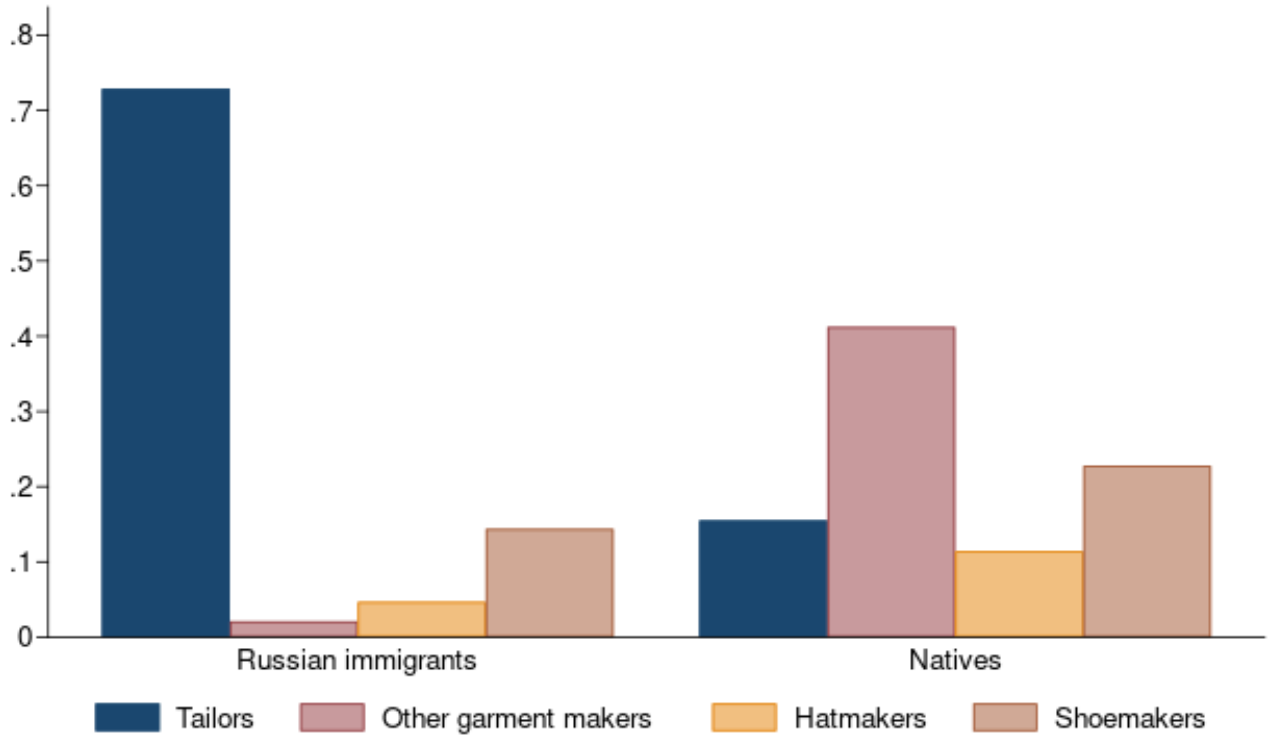
A Appendix Figures

Figure A.1: Employment Distribution by Sector in England in 1881



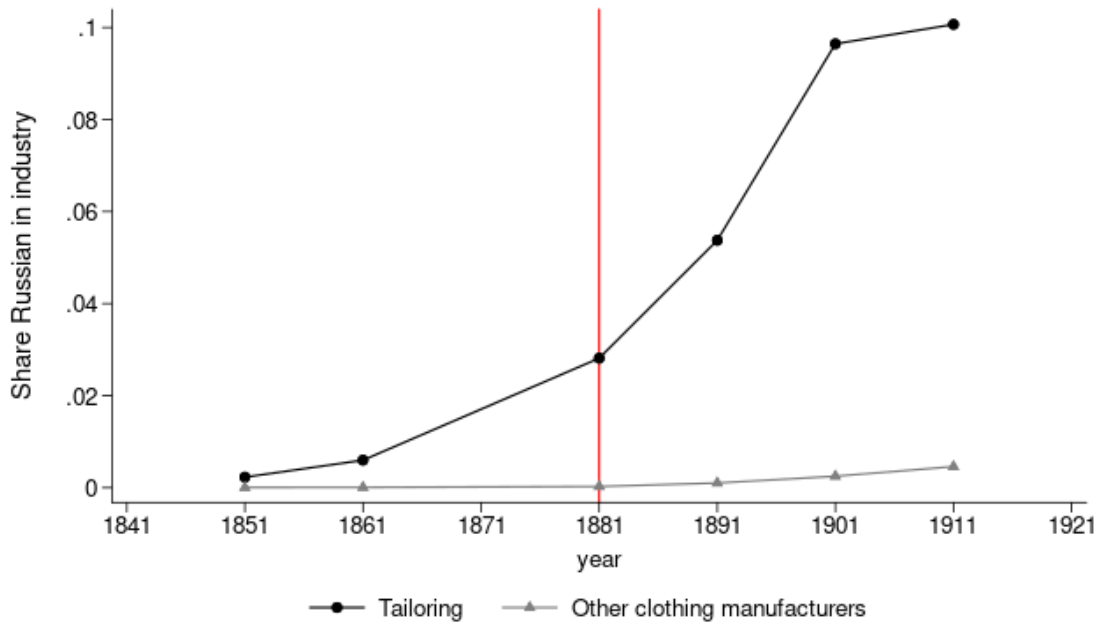
Source: I-CeM data 1881.
Notes: The treemap illustrates the distribution of employment across sectors in England in 1881. The clothing sector was the fourth largest sector of employment, accounting for 8% of the total workforce in this year. Sector names are omitted from the smallest cells for legibility but correspond to: 7, Fishing; 8, Utilities and Sanitation; 13, Brick, Cement, Pottery and Glass; 14, Chemicals; 19, Precious Metals and Instruments; and 20, Leather and Skins.

Figure A.2: Industrial distribution by group of clothing workers in 1881



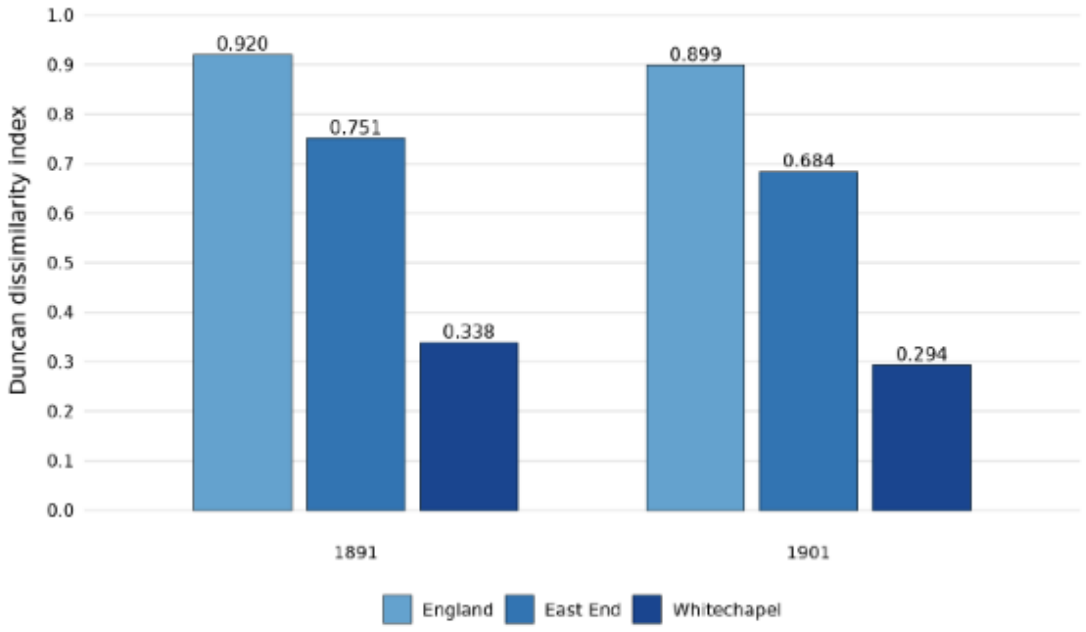
Source: I-CeM data 1881.
Notes: The clothing sector comprised three main industries: shoemaking, hatmaking, and garment manufacturing. Garment manufacturing comprised of tailors, and other manufacturers that included corset and stay makers, dressmakers, shirtmakers, and seamstresses. The figure shows the distribution of Russian clothing workers across these industries and compares it with that of native clothing workers in England in 1881.

Figure A.3: Share of Russian workers in tailoring and adjacent clothing occupations



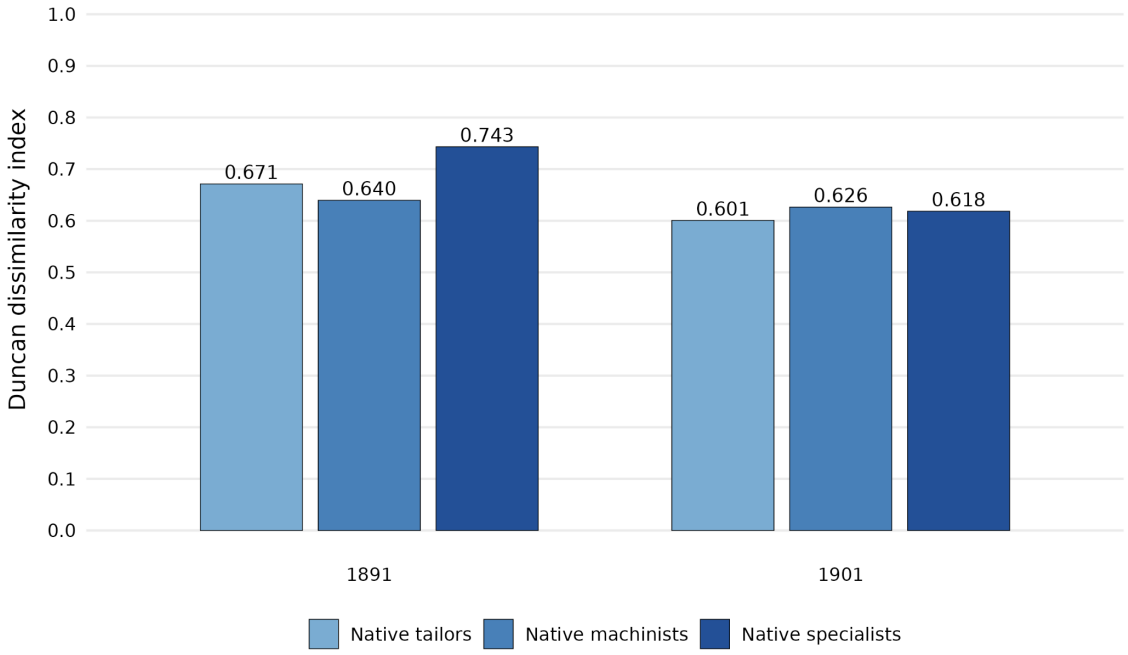
Source: I-CeM data 1851–1911.
Notes: The figure plots the share of Russian-born workers in tailoring and in adjacent clothing occupations (dressmakers + stay and corset makers + shirtmakers and seamstresses) over time.

Figure A.4: Street-level dissimilarity between native and Russian tailors



Source: I-CeM data 1891-1901 matched to street geometries by Rhodes (2025).
Notes: The figure reports Duncan dissimilarity indices between native and Russian tailors at the street level for England, the East End of London, and Whitechapel in 1891 and 1901. The East End consists of Whitechapel, St George In The East, Mile End Old Town, Stepney, Bethnal Green, Shoreditch, and Poplar. Streets are included if they contain at least one matched tailor. Higher values indicate greater segregation across streets within each geography.

Figure A.5: Within-district street-level dissimilarity in England



Source: I-CeM data 1891-1901 matched to street geometries by Rhodes (2025).
Notes: The figure reports Duncan dissimilarity indices computed within districts in England between native tailors and Russian tailors, between native machinists and Russian tailors, and between native specialists and Russian tailors, for 1891 and 1901. The plotted values are population-weighted means across districts. The sample is restricted to districts whose increase in Russian tailors between 1881 and 1901 is positive as a share of national Russian-tailor growth. Streets are included if they contain at least three matched tailors. Higher values indicate greater segregation across streets within districts.

B Appendix Tables

Table B.1: Street-match coverage for tailors, machinists, and specialists

	1891	1901
Panel A. Native tailors, machinists, and specialists		
Number of native tailors	156,329	167,183
Street-match rate (%)	59.1	62.7
Number of native machinists	4,269	16,242
Street-match rate (%)	55.5	56.2
Number of native specialists	2,265	6,666
Street-match rate (%)	48.4	52.0
Panel B. Russian tailors, machinists, and specialists		
Number of Russian tailors	9,914	19,688
Street-match rate (%)	47.1	50.7
Number of Russian machinists	867	2,681
Street-match rate (%)	49.6	44.1
Number of Russian specialists	820	2,655
Street-match rate (%)	37.9	42.4

Notes: This table reports, for the 1891 and 1901 census cross-sections used in the street-level mechanism analysis, the number of native and Russian tailors, machinists, and specialists in our sample together with the corresponding street-match rate for each group. A worker is considered street-matched when the residential address recorded in the I-CeM census can be successfully linked by Rhodes (2025) to a historical street geometry. Street-match rates are computed separately for each occupation, origin group, and year.

Table B.2: First-stage results

	Russian inflow 1881–1891	Russian inflow 1891–1901
	(1)	(2)
Shift-share, 1851 shares	0.814***	0.452***
	(0.061)	(0.026)
Observations	554	554
R^2	0.5646	0.2372
Excluded-instrument Wald F-stat	177.14	299.56

Notes: This table presents results from district-level first-stage regressions of the decennial change in Russian immigrants in tailoring, scaled by the lagged broader local native clothing-manufacturing base, on the shift-share instrument constructed using the cross-district shares of Russian tailoring workers in 1851. Columns (1) and (2) report results for the decades 1881–1891 and 1891–1901 respectively. The change in the average age of workers in the district is included as a control. Robust standard errors are clustered at the district level and reported in parentheses. The reported statistic is the cluster-robust Wald F-statistic for the excluded instrument. Significance: 10% (*), 5% (**), and 1% (***).

Table B.3: First-stage with location of native tailors in 1851 as instrument

	Russian inflow 1881–1891 (1)	Russian inflow 1891–1901 (2)
Shift-share, 1851 native tailoring shares	1.158	0.759
	(0.909)	(0.558)
Observations	554	554
R^2	0.0168	0.0104
Excluded-instrument Wald F-stat	1.62	1.85

Notes: This table presents results from district-level first-stage regressions of the decennial change in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base, on a shift-share instrument constructed using the cross-district shares of native tailoring workers in 1851. Columns (1) and (2) report results for the decades 1881–1891 and 1891–1901 respectively. The change in the average age of workers in the district is included as a control. Robust standard errors are clustered at the district level and reported in parentheses. The reported statistic is the cluster-robust Wald F-statistic for the excluded instrument. Significance: 10% (*), 5% (**), and 1% (***).

Table B.4: The impact on the occupational composition of native tailoring

	Native machinist share		Native specialist share		Native generalist share	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. 1881–1891						
Russian tailor inflows	0.029***	0.042***	0.038***	0.032***	-0.067***	-0.074***
	(0.009)	(0.007)	(0.006)	(0.004)	(0.006)	(0.009)
R^2	0.0031		0.0223		0.0110	
KP F-stat		177.12		177.12		177.12
No. of districts	552	552	552	552	552	552
Panel B. 1891–1901						
Russian tailor inflows	0.078**	0.083**	0.060***	0.044***	-0.139***	-0.128***
	(0.037)	(0.034)	(0.016)	(0.006)	(0.053)	(0.033)
R^2	0.0078		0.0307		0.0166	
KP F-stat		299.52		299.52		299.52
No. of districts	552	552	552	552	552	552

Notes: The table reports regressions of decennial changes in native occupational shares within tailoring on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. All specifications include the decennial change in the average age of workers in the district. Regressions exploit variation across districts in England. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. The sample is restricted to districts with positive native tailoring employment in 1881, 1891, 1901, and 1911 so that occupational shares are defined consistently and are comparable over time. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), 1% (***).

Table B.5: Contribution of Russian inflows to mechanization in tailoring

	Machinist share with inflows (%)	Machinist share w/o inflows in that decade (%)	Russian contribution (pp)	Decade rise accounted for (%)
Panel A. Native tailors only				
1881	2.005	2.005	0.000	–
1891	2.731	2.590	0.141	19.42
1901	9.716	9.340	0.376	5.38
Panel B. Total tailoring (natives + Russians)				
1881	2.051	2.051	0.000	–
1891	3.090	2.611	0.479	46.10
1901	10.127	9.547	0.580	8.24

Notes: This table reports back-of-the-envelope estimates of the contribution of Russian inflows to the rise in sewing-machine use in tailoring. Panel A presents the lower-bound effect on the machinist share among native tailors only. Panel B reports a broader partial-equilibrium measure for tailoring overall, including machinists among Russian tailors themselves in addition to the induced increase in mechanization among natives. In both panels, the counterfactual path is constructed by combining district-level IV employment effects on native tailors and native machinists with realized Russian inflows. The second column reports the counterfactual machinist share that would have prevailed absent Russian inflows in the corresponding decade, holding fixed the effects realized in earlier decades. The third column reports the implied decade-specific contribution of Russian inflows in percentage points. The final column expresses this contribution as a share of the observed increase in the machinist share within the same decade. Because these exercises capture direct local exposure rather than broader diffusion beyond directly exposed districts, both should be interpreted as partial-equilibrium estimates, with Panel A providing the more conservative lower bound.

Table B.6: Contribution of Russian inflows to specialization in tailoring

	Specialist share with inflows (%)	Specialist share w/o inflows in that decade (%)	Russian contribution (pp)	Decade rise accounted for (%)
Panel A. Native tailors only				
1881	0.723	0.723	0.000	–
1891	1.449	1.334	0.115	15.89
1901	3.988	3.792	0.196	7.72
Panel B. Total tailoring (natives + Russians)				
1881	0.783	0.783	0.000	–
1891	1.856	1.365	0.491	45.76
1901	4.988	4.143	0.845	26.98

Notes: This table reports back-of-the-envelope estimates of the contribution of Russian inflows to the rise in specialization within tailoring. Panel A presents the lower-bound effect on the specialist share among native tailors only. Panel B reports a broader partial-equilibrium measure for tailoring overall, including specialists among Russian tailors themselves in addition to the induced increase in specialization among natives. In both panels, the counterfactual path is constructed by combining district-level IV employment effects on native tailors and native specialists with realized Russian inflows. The second column reports the counterfactual specialist share that would have prevailed absent Russian inflows in the corresponding decade, holding fixed the effects realized in earlier decades. The third column reports the implied decade-specific contribution of Russian inflows in percentage points. The final column expresses this contribution as a share of the observed increase in the specialist share within the same decade. Because these exercises capture direct local exposure rather than broader diffusion beyond directly exposed districts, both should be interpreted as partial-equilibrium estimates, with Panel A providing the more conservative lower bound.

Table B.7: The impact on native occupational reorganization by gender within tailoring

	Native men			Native women		
	Machinists (1)	Specialists (2)	Generalists (3)	Machinists (4)	Specialists (5)	Generalists (6)
Panel A. 1881–1891						
Russian tailor inflows	0.025***	0.006***	0.125***	0.018***	0.027***	0.037
	(0.001)	(0.001)	(0.033)	(0.002)	(0.001)	(0.033)
KP F-stat	177.14	177.14	177.14	177.14	177.14	177.14
No. of districts	554	554	554	554	554	554
Panel B. 1891–1901						
Russian tailor inflows	0.055***	0.012***	-0.069	-0.004	0.015***	-0.287***
	(0.002)	(0.002)	(0.062)	(0.010)	(0.003)	(0.083)
KP F-stat	299.56	299.56	299.56	299.56	299.56	299.56
No. of districts	554	554	554	554	554	554

Notes: The table reports IV coefficients from regressions of decennial changes in native tailoring outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. All specifications include the decennial change in the average age of workers in the district. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), 1% (***).

Table B.8: Spillover effects on native employment among corset and stay makers

	Employment status			Gender	
	Native employees	Native employers	Native self-employed	Native men	Native women
	(1)	(2)	(3)	(4)	(5)
Panel A. 1881–1891					
Russian tailor inflows	-0.014	-0.000	0.002	0.000	-0.011
	(0.012)	(0.000)	(0.002)	(0.001)	(0.010)
KP F-stat	177.14	177.14	177.14	177.14	177.14
No. of districts	554	554	554	554	554
Panel B. 1891–1901					
Russian tailor inflows	-0.008	-0.001	-0.001	-0.002	-0.008
	(0.007)	(0.001)	(0.001)	(0.001)	(0.006)
KP F-stat	299.56	299.56	299.56	299.56	299.56
No. of districts	554	554	554	554	554

Notes: The table reports IV coefficients from regressions of decennial changes in native corset and stay maker outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. The overall effect on native workers in this occupation is reported in Appendix Table 6. All specifications include the decennial change in the average age of workers in the district. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), and 1% (***).

Table B.9: Spillover effects on native employment among shirtmakers and seamstresses

	Employment status			Gender	
	Native employees	Native employers	Native self-employed	Native men	Native women
	(1)	(2)	(3)	(4)	(5)
Panel A. 1881–1891					
Russian tailor inflows	-0.095**	0.003	0.029	-0.005	-0.058**
	(0.044)	(0.002)	(0.019)	(0.003)	(0.026)
KP F-stat	177.14	177.14	177.14	177.14	177.14
No. of districts	554	554	554	554	554
Panel B. 1891–1901					
Russian tailor inflows	-0.033	0.001	-0.027	0.000	-0.059
	(0.029)	(0.001)	(0.018)	(0.004)	(0.036)
KP F-stat	299.56	299.56	299.56	299.56	299.56
No. of districts	554	554	554	554	554

Notes: The table reports IV coefficients from regressions of decennial changes in native shirtmaker and seamstress outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. The overall effect on native workers in this occupation is reported in Appendix Table 6. All specifications include the decennial change in the average age of workers in the district. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), and 1% (***).

Table B.10: The impact on native reorganization within tailoring, controlling for low-status occupational shares in 1851

	Native tailors	Native machinists	Native specialists	Native generalists
	(1)	(2)	(3)	(4)
Panel A. 1881–1891				
Russian tailor inflows	0.235***	0.043***	0.033***	0.159***
	(0.058)	(0.003)	(0.001)	(0.058)
Share bottom 10% social status in district, 1851	0.0014*	0.0001	0.0000	0.0013*
	(0.0008)	(0.0001)	(0.0000)	(0.0008)
KP F-stat	176.96	176.96	176.96	176.96
No. of districts	554	554	554	554
Panel B. 1891–1901				
Russian tailor inflows	-0.280*	0.050***	0.028***	-0.357**
	(0.147)	(0.010)	(0.005)	(0.144)
Share bottom 10% social status in district, 1851	0.0007	0.0001	0.0001	0.0005
	(0.0008)	(0.0001)	(0.0001)	(0.0007)
KP F-stat	299.47	299.47	299.47	299.47
No. of districts	554	554	554	554

Notes: The table reports IV regressions of decennial changes in native tailoring outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. All specifications control for the decennial change in the average age of workers in the district and the district's 1851 share of occupations in the bottom 10% of the social-status distribution. Regressions exploit variation across 554 districts in England. Russian inflows are instrumented using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Reported standard errors are clustered at the district level. The Kleibergen-Paap weak-identification statistic is reported as the KP F-stat. Significance: 10% (*), 5% (**), 1% (***).

Table B.11: Russian presence in high-exposure districts

	1891	1901
Panel A. Overall Russians / overall natives (%)		
High-exposure districts	2.32	5.17
Other districts	0.02	0.04
Panel B. Russian tailors / native tailors (%)		
High-exposure districts	13.13	27.43
Other districts	0.24	0.62
Districts in high-exposure group	33	33
Districts in other group	521	521

Notes: This table compares the Russian presence in the overall local population with the Russian presence within tailoring. High-exposure districts are defined separately in 1891 and 1901 as districts in the top quartile of the Russian tailor shock as predicted by our instrument. The entries report the shares observed after each decade shock. Panel A reports the ratio of Russian immigrants to overall natives in each group of districts. Panel B reports the ratio of Russian immigrant tailors to native tailors. All entries are reported in percentage terms.

Table B.12: The impact on native reorganization within tailoring - cutters considered as specialists

	Native tailors		Native machinists		Native specialists		Native generalists	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)
Panel A. 1881–1891								
Russian tailor inflows	0.550	0.238***	0.050***	0.043***	0.074**	0.047***	0.426	0.148***
	(0.340)	(0.058)	(0.016)	(0.003)	(0.032)	(0.003)	(0.291)	(0.057)
R^2	0.0266		0.0528		0.0550		0.0194	
KP F-stat		177.14		177.14		177.14		177.14
No. of districts	554	554	554	554	554	554	554	554
Panel B. 1891–1901								
Russian tailor inflows	-0.037	-0.278*	0.063**	0.050***	0.048**	0.044***	-0.148***	-0.372***
	(0.039)	(0.147)	(0.026)	(0.010)	(0.019)	(0.009)	(0.053)	(0.141)
R^2	0.0007		0.0139		0.0189		0.0088	
KP F-stat		299.56		299.56		299.56		299.56
No. of districts	554	554	554	554	554	554	554	554

Notes: The table reports regressions of decennial changes in native tailoring outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. In this robustness version, cutters are considered as specialists and we estimate the same regressions as in Table 4. All specifications include the decennial change in the average age of workers in the district as a control. Regressions exploit variation across 554 districts in England. IV specifications instrument Russian inflows using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Standard errors are clustered at the district level. Significance: 10% (*), 5% (**), 1% (***).

Table B.13: The impact on native reorganization within tailoring, controlling for high-status occupational shares in 1851

	Native tailors	Native machinists	Native specialists	Native generalists
	(1)	(2)	(3)	(4)
Panel A. 1881–1891				
Russian tailor inflows	0.131	0.034***	0.031***	0.066
	(0.105)	(0.005)	(0.001)	(0.101)
Share top 10% social status in district, 1851	0.0060***	0.0005***	0.0001**	0.0054***
	(0.0015)	(0.0001)	(0.0001)	(0.0015)
KP F-stat	163.15	163.15	163.15	163.15
No. of districts	554	554	554	554
Panel B. 1891–1901				
Russian tailor inflows	-0.323*	0.031**	0.023***	-0.377**
	(0.174)	(0.013)	(0.008)	(0.159)
Share top 10% social status in district, 1851	0.0023	0.0010***	0.0002**	0.0011
	(0.0018)	(0.0003)	(0.0001)	(0.0017)
KP F-stat	249.99	249.99	249.99	249.99
No. of districts	554	554	554	554

Notes: The table reports IV regressions of decennial changes in native tailoring outcomes on decennial changes in Russian immigrants in core tailoring, scaled by the lagged broader local native clothing-manufacturing base. All specifications control for the decennial change in the average age of workers in the district and the district's 1851 share of occupations in the top 10% of the social-status distribution. Regressions exploit variation across 554 districts in England. Russian inflows are instrumented using the interaction between the district's 1851 Russian settlement share in core tailoring and the corresponding national Russian inflow, scaled by the local 1851 broader native clothing base. Reported standard errors are clustered at the district level. The Kleibergen-Paap weak-identification statistic is reported as the KP F-stat. Significance: 10% (*), 5% (**), 1% (***).

C Sewing machine diffusion: America, Britain, Russia

The sewing machine was not immediately affordable to the working tailor. The exception to this was in America. Following the patent pool Albany Agreement of 1856, Edward Clark at the Singer Company established an installment payment programme, and by the 1860s hundreds of thousands of the machines were produced in the US every year. Saturation was reached fairly quickly, and by 1879 the US market accounted for only 48 percent of Singer's total sales (Godley, 2006). Much of the global market for the new machines was at this point in Europe.

Sewing machines had been available in England from the 1860s, but were still expensive, selling for £7–10. In 1862, Singer began selling imported machines. The company built its first small factory near Glasgow in 1867, established the installment programme in 1873, and launched its formidable system of sales via canvassers in 1877 [20]. In 1885 Singer opened what was then the largest factory in Europe, on 46 acres of farmland, at Kilbowie in Scotland. Two and a half miles of rail were constructed to connect the factory with nearby towns. By 1881 a machine could be purchased for £4 4s, or rented for 2s 6d weekly[21].

Diffusion reached Russia slowly[22]. In 1902 the Podolsk factory opened, and by 1908 was producing around 440 000 machines a year (Carstensen, 1984). Installment on credit lacked legal standing until February 1904 (Potkina, 2008, fn. 15, citing *Collections of Laws and Orders of the Government*, St Petersburg, 1904, pt. 1, no. 549). The change in affordability between 1900 and 1910 was substantial. In 1900 the machine cost on average 74.4 rubles, with a down payment of 10 rubles which was very difficult for most customers to meet (Carstensen, 1984). By 1912, the machine was 25 rubles, with installment payments of 1 ruble (Yelets, 2021).

The gap in affordability for tailors in Britain and America was meaningful. In Britain a coat machinist earning 7s. a day in the early 1880s could buy a Singer outright for £4 4s. or on hire at 2s. 6d. weekly. The wages given to us by Potter (1889) in Table B15 make that approximately 12 days work. In the Pale of Settlement, where Rubinow (1907) puts tailors' earnings at 100–200 rubles a year, a machine at 74 rubles cost roughly six months of work, and it is not clear whether installment payments were routinely available prior to 1904. In the period between 1880–1900 the sewing machine was readily available to tailors in Britain, but at the very frontier of affordability in the Pale of Settlement. Rubinow (1907) tells us that there is some evidence of master tailors in the Pale combining their workshops in order to be able to afford the machine. At 74–100 rubles, a sewing machine cost a tailor in the Pale roughly what emigration to America did (and much less than the 20 ruble fare to travel to London) (Subbotin, 1890).

[20] Singer canvassers visited customers at their homes, demonstrating how the machine operated, and credit. Each was assigned a fixed district. The data on machine ownership in Jewish workshops in the East End of London in Table B15 result from Beatrice Potter consulting the records of the Singer canvassers(Potter, 1889).

[21] See the advertisement in Singer Manufacturing Company (1881).

[22] Records collected by Godley (1997) show that 11% of the population in England, Australia, and New Zealand had a sewing machine by 1914. In Western Europe this was 5-7%, and in Germany and Austria-Hungary it was 5%. Russia was at 4% by this point, but the entire diffusion took place after 1904.

Table C.1: Sewing machine availability to working tailors: America, Britain, Russia, 1850–1914

Period	America	Britain	Russia
1850–55	Machines exist; priced ∼$100+, far beyond artisan reach.	—	—
1855–60	**Installment credit** by Edward Clark in 1856. Combination pool fixes license fees, keeping prices high	Import only	—
1860–65	Civil War demand: production scaling. Price falling but still a capital purchase	**1862: London agency opens** Woodruff appointed to the London office in 1864.	—
1865–70	Annual sales increase 12×, from 62k in 1866 to 770k in 1872. Family market vital	**1867: Glasgow manufacture begins**	1865: sales via sub-agent only — import, no local network
1870–75	>400,000 units/yr from Singer alone	Installment programme introduced in 1873	Small local presence
1875–80	570,000 domestic machines/yr across US firms. Patent pool protection expires in 1877. Prices cut to $30	1875: 30,000 machines produced. Canvasser-collector system establish in 1877. Retail outlets: 26 in 1879 to 303 in 1885	Neidlinger (German manager) takes direct charge and organisation-building begins
1880–85	Effective saturation in the clothing trades	**1884: 90,000 machines produced.** Widely available - price within reach of a workshop on credit	**81 branches by early 1880s** (10 depots St Petersburg, 5 Moscow). Distribution exist, prices high.
1885–90	—	**1885: Kilbowie opens at 8,000/week.** UK a production centre, not an import market	Price ∼70–100 rubles (est.) Characterised as "articles of luxury"
1890–95	—	Saturated	Available to purchase, not affordable to working tailors
1895–1900	—	—	89,000 imported machines sold in 1895. Russian subsidiary Kompaniya Singer, established June 1897. Singer sales had grew 35between 1895 and 1898. Plans move forward to open factory in Russia
1900–05	—	—	1902: Singer factory at Podolsk opens. **1904: retail credit codified.** Affordability constraint lifts
1905–14	—	—	6× sales growth, 7.6× output value growth 1900–14. From "articles of luxury" to "accessible to all classes"

Sources: America and Britain from Godley (2006) and Jones and Kiron (2003). Russia from Potkina (2008) and Carstensen (1984).

D Jewish coat shops and ready-to-wear outlets

Table D.1: Types of Jewish coat-shops, East London, 1888

	Wage per day	Hours of work	Rate per hour
Section I, Class C — Best Bespoke. One machine; four hands.			
Tailor (baster)	7*s* to 9*s*	13–14	6*d* to 8*d*
Tailor (presser)	7*s* to 9*s*	13–14	6*d* to 8*d*
Tailor (machinist)	7*s* to 10*s*	13–14	6*d* to 9*d*
Tailoress	4*s* to 6*s*	12	4*d* to 6*d*
Remarks: 3 to 4 coats per day. Contractor one of the tailors. Tailoress will make button-holes.			
Section II, Class C — Bespoke and Stock. Two machines; eight hands.			
General tailor	7*s* 6*d* to 8*s* 6*d*	13–14	612*d* to 712*d*
General tailor	6*s* to 6*s* 6*d*	13–14	512*d* to 6*d*
Machinist (best)	7*s* to 7*s* 6*d*	13–14	612*d* to 7*d*
Machinist (plain)	5*s*	13–14	412*d*
Presser	7*s* 6*d* to 8*s* 6*d*	13–14	612*d* to 712*d*
General hand (male)	5*s*	13–14	412*d*
General hand (female)	2*s* 6*d*	12	212*d*
Buttonholer (girl)	3*s* 6*d*	Piecework	4*d*
Remarks: 10 to 12 coats per day. Contractor will be one of the general tailors. An apprentice may be kept at 12*s* per week to fell sleeve linings and sew on buttons, and learn trade.			
Section III, Class C — Stock and Common. Two (or three) machines; eight or nine hands.			
Machinist (best)	6*s* to 7*s*	13–14	5*d* to 612*d*
Machinist (plain)	3*s* to 4*s*	Indefinite	2*d* to 3*d*
Baster	4*s* to 5*s* 6*d*	13–14	334*d* to 5*d*
Presser	6*s*	13–14	5*d*
General hand (female)	3*s* 6*d*	12	312*d*
Feller (girl)	2*s* 6*d*	12	212*d*
Feller (girl)	2*s*	12	2*d*
Buttonholer (girl)	3*s*	Piecework	314*d*
Remarks: 15 to 25 coats per day. Contractor will be baster or first machinist. The general hand will probably work a third machine when needed, or there may be third machinist and wife as general hand.			
Section IV, Class C — Very Common. Two machines; five hands.			
Machinist (best)	6*s*	13–14	5*d*
Machinist (plain)	3*s*	Indefinite	1*d* to 212*d*
Presser	6*s*	13–14	5*d*
General hand (female)	1*s* 6*d*	Indefinite	1*d* to 112*d*
Feller (girl)	Nominal	Indefinite	Nominal
Remarks: 15 to 20 coats per day. Contractor will be presser or first machinist. Indefinite hours. May employ "greener" as second machinist at nominal wage. Buttonholer: outdoor hand, 112*d* to 2*d* per hour.			

Source: Potter (1889, p. 230).

Table D.2: Growth of ready-to-wear clothing outlets, 1880–1915

Panel A. Number of outlets								
	1880	1885	1890	1895	1900	1905	1910	1915
Men's and boys' wear	44	119	211	349	570	854	1,085	1,259
Women's and girls' wear	—	20	77	153	245	342	472	543
Footwear	500	757	1,231	1,967	2,589	2,962	3,544	3,879
Total	544	896	1,519	2,469	3,404	4,158	5,101	5,681
Panel B. Percentage increase								
	1880–85	1885–90	1890–95	1895–1900	1900–05	1905–10	1910–15	
Men's and boys' wear	170.4	77.3	65.4	63.3	49.8	27.0	16.0	
Women's and girls' wear	—	285.0	98.7	60.1	39.6	38.0	15.0	
Footwear	51.4	62.6	59.8	31.6	14.4	19.6	9.4	
Total	64.7	69.5	62.5	37.8	22.1	22.6	11.4	

Source: James B. Jefferys, *Retail Trading in Britain, 1850–1950* (Cambridge, 1954), Table 86.
Notes: Panel A reports the number of ready-to-wear clothing outlets by type. Panel B reports the percentage increase over each five-year interval. Percentage changes reproduce those reported in the original table.

E Constructing Granular Information on Occupation

Every British census taken between 1851 and 1911 asked individuals to provide descriptions of their occupations. William Farr, the superintendent of the statistical department at the General Register Office (GRO) in the United Kingdom at the time, indicated that the responses given by citizens should capture five key aspects of their work: "skill, talent, or intelligence; tools, instruments, machinery or structures; materials; processes; products".[23] Indeed, these aspects are often reflected in the responses householders provided. The descriptions given varied significantly, ranging from one-word summaries to more detailed responses with 10-15 words.

The Integrated Census Microdata project (ICeM) has digitized the original English Census data for the decades between 1851-1911, excluding census year 1871. The new ICeM dataset makes individual level census observations digitally available for the first time (Higgs and Schurer, 2020), and has substantially expanded the frontiers of research on British occupational structure over the second half of the 19th century. However, when the ICeM project digitized the data, they retained the pre-existing, industry level, categorization of occupation. This left the more granular data on occupation sealed in the strings describing occupation. Our approach to extracting the "tasks" from the strings is twofold. First, we make use of a straightforward deterministic approach. Second, we employ an incremental machine learning approach, as illustrated in the figure below. Both approaches have been previously used to construct tasks for the boot-making industry in Victorian Britain (Vipond, 2022).

E.1 Deterministic Approach

The process of constructing the "task-level" classification proceeds in three steps: all unique strings describing occupation for Tailors are collected, then tokenized, and a set of categories is constructed from the most frequent "task" terms.

First, we collect the complete set of tailors in England across all census years. Second, we determine the main set of tasks present in the unique strings. We employ a filtration process to subset to the "tasks" which occur most frequently in the strings. The first part of the filtration leverages Zipf's Law, the highly skewed distribution of the strings. We extract the "task" words available in those strings. These are now identified categories of "tasks" in tailoring. The remaining unique character strings, those not accounted for by the initial sweep, are then extracted and tokenized. The frequencies of individual words are tallied. "Task" words found to be most frequent are added to the set of tailor "tasks".

Finally, once the categories - or types of task - have been discovered, the character strings in the "occupation" are parsed and assigned to the new "task" categories. The topic modelling process results in the construction of a dictionary, with topic categories assigned to keywords and their spelling variations. From this point, assigning strings to task categories based on the

[23] Census(1861): general report

presence of the keywords in the string is straightforward. For example, in Table 1, the third observation includes the keyword "machinist", so this person will be assigned to the category machinist. It should be noted that the "task" level could be dis-aggregated further. For example, all "cutters" are collected into one category, irrespective of what type of material they cut. Likewise, no distinction is made regarding what material is used in the tailoring process.

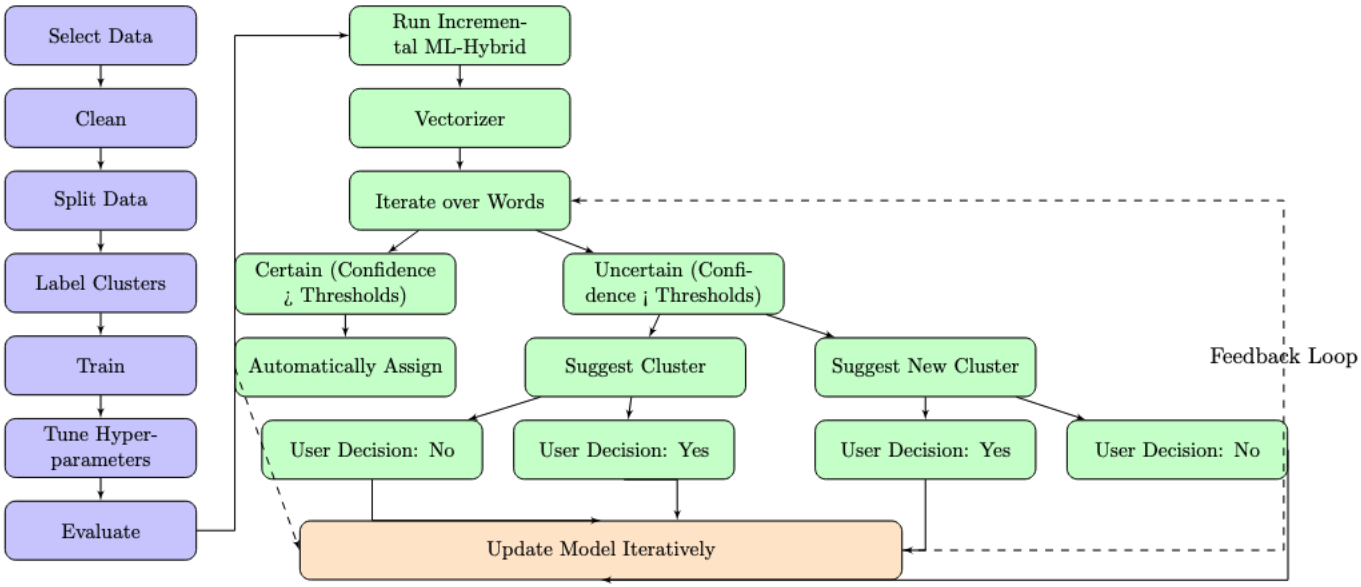
E.2 Machine Learning Approach

The process is illustrated in Appendix Figure E.1. It begins with a traditional machine learning pipeline. Data is selected and cleaned, and then split into training and test sets. Again, Zipf's law is leveraged. The most frequent set of strings is extracted, tokenized, and clustered. Clusters are on the basis of tasks. A model is then trained on the labeled clusters, and performance fine-tuned through hyper-parameter optimization. The model's accuracy is evaluated on the test data.

Following this, the workflow transitions into an Incremental Learning Hybrid phase, where the model is continuously refined. In this phase, a vectorizer processes new incoming data. The model iterates over individual tokens, classifying them based on its confidence levels. When the model is highly confident, it automatically assigns labels. For uncertain cases, it suggests potential clusters and incorporates feedback from the user, either confirming or rejecting these suggestions. Over time, the model is updated iteratively, incorporating both automatic classifications and user feedback, which helps it improve and adapt to new patterns in the data. This iterative feedback loop ensures that the model's performance improves progressively as more data is processed.

We take this human-in-the-loop incremental learning approach to classification for two main rea- sons. Firstly, while the straightforward deterministic model employed for bootmakers and tailors is effective, it does not scale efficiently. This limitation becomes apparent as we extend our analysis to Task data across all industries. The machine learning approach scales. To ensure accuracy, we use the results from the manual deterministic approach as a ground truth for additional validation. Secondly, we find existing topic modeling methods, which often require setting a number of predefined categories, inadequate. The incremental machine learning allows me to generate categories flexibly, and incorporate knowledge of the occupational structure of the period. In practice, it is essentially supervised learning over multiple iterations.

Figure E.1: Incremental Machine Learing



Notes: The figure presents a diagram describing the process of data construction with the machine learning approach. It begins with a traditional pipeline where data is cleaned, split, and tokenized, followed by clustering based on tasks. A model is trained on the labeled clusters and fine-tuned through hyper-parameter optimization. The workflow then transitions into an Incremental Learning Hybrid phase, where the model iteratively refines its predictions using user feedback and newly processed tokens.

F IV vs OLS standard errors

This appendix discusses why the IV standard errors in the machinist regressions are smaller than the corresponding OLS standard errors. The key reason is that IV places more weight on districts whose Russian inflows are strongly predicted by the historical settlement instrument, and in these data those are also the districts in which treatment exposure is more closely aligned with the outcome in the second stage. As a result, IV relies relatively more on districts with smaller second-stage residuals, which improves precision relative to OLS. In practice, the first stage is strongest in Whitechapel, while other high-inflow districts, such as St George East and Leeds, are only weakly predicted by the instrument. We then show how this difference in weighting, together with differences in OLS residuals across districts, helps explain why IV is more precise than OLS in these specifications.

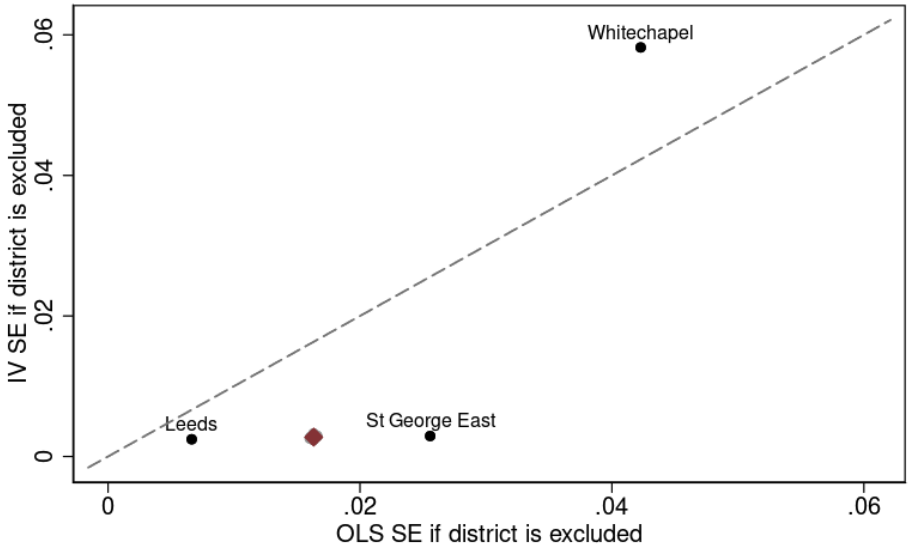
We begin by showing, in Figure F.1, how the OLS and IV standard errors vary when each of the 554 districts is excluded from the regression one at a time. Each point reports the OLS standard error on the horizontal axis and the IV standard error on the vertical axis after dropping a given district. Points below the 45-degree line indicate that the IV standard error remains smaller than the OLS standard error even when that district is removed. In both 1891 and 1901, this is true for most districts. When we exclude Whitechapel IV standard errors become larger than OLS, showing that Whitechapel is especially important for IV precision. By contrast, excluding Leeds in 1891 lowers the OLS standard error relative to the full sample, indicating that this district contributes to OLS uncertainty.

In Figure F.2 we compare actual treatment in the district against first-stage fitted treatment. Districts close to the 45-degree line are those whose treatment is strongly predicted by the instrument. In both years, Whitechapel lies close to the line, indicating that its Russian inflow is well captured by the instrument. By contrast, St George in The East lies below the line in both years, and Leeds does so in 1891, showing that these districts have high actual treatment but are less strongly predicted by the instrument relative to Whitechapel. This is indicative of the difference in the weight the IV places across districts relative to OLS.

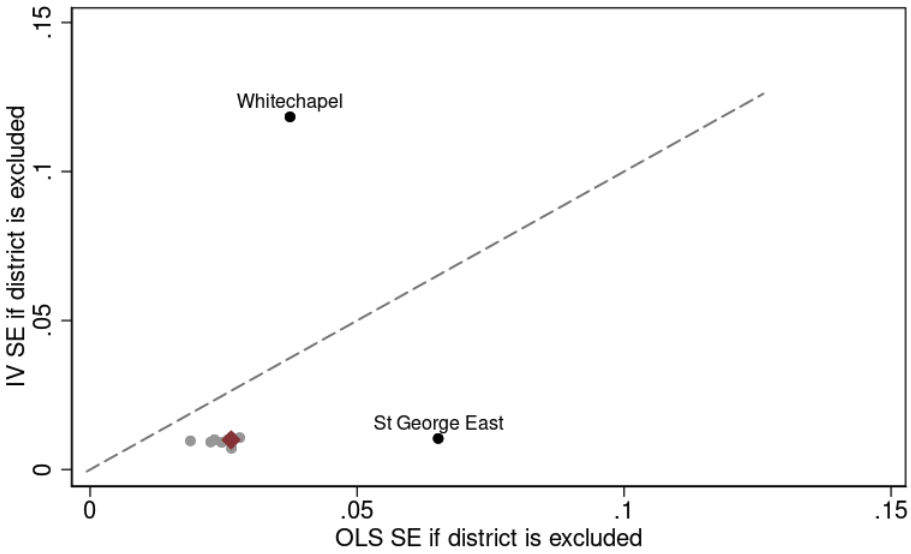
Finally, Figure F.3 plots squared OLS residuals against actual treatment. The figure shows that some districts contribute disproportionately to OLS uncertainty because they combine substantial treatment exposure with relatively poor fit in the OLS regression. Leeds is a clear example in both decades. By contrast, Whitechapel combines very high treatment exposure with very small OLS residuals, which helps explain why it is an important source of identifying variation without generating comparable second-stage noise. St George East also has a very small OLS residual despite large actual treatment, but because it is only weakly predicted by the instrument, it contributes much less to IV precision than Whitechapel. As a result, IV places relatively more weight on Whitechapel than on districts such as Leeds and St George East, which helps explain why IV standard errors are smaller than OLS standard errors in these specifications.

Figure F.1: OLS and IV standard errors when individual districts are excluded

Panel A. 1881-1891



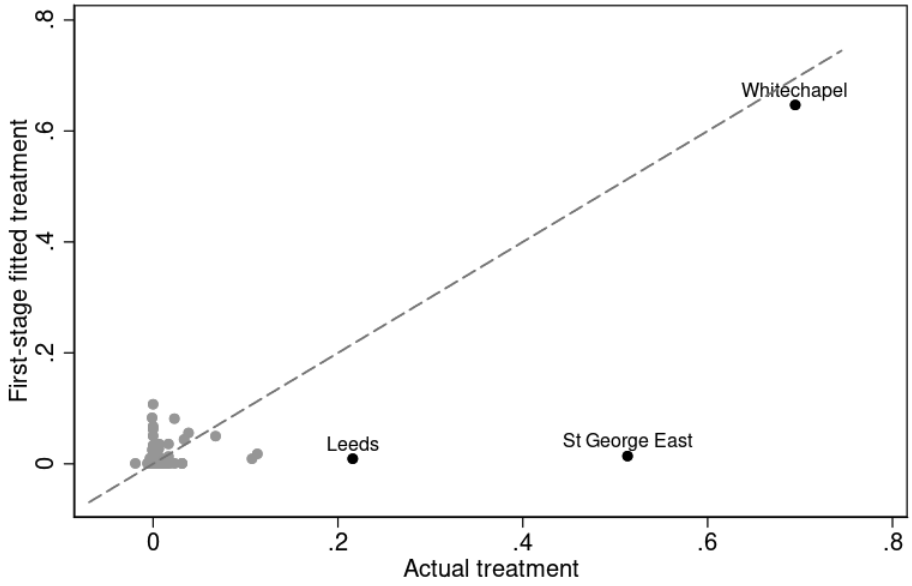
Panel B. 1891-1901



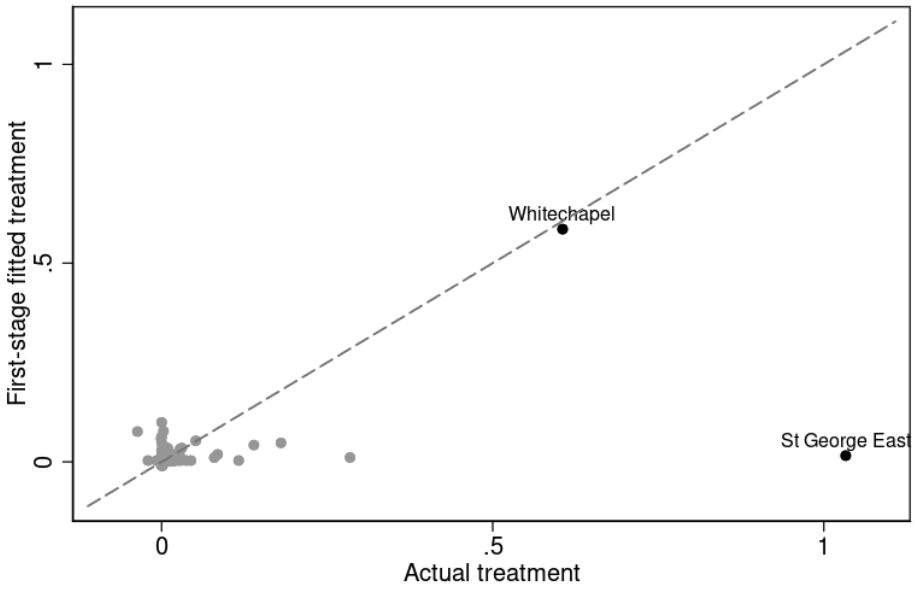
Notes: Each point shows the pair of standard errors obtained after dropping one district at a time from the regression. The horizontal axis reports the OLS standard error and the vertical axis the IV standard error. The red diamond marks the full-sample pair of standard errors. Points below the 45-degree line imply that the IV standard error is smaller than the OLS standard error after excluding that district.

Figure F.2: Actual and first-stage predicted treatment

Panel A. 1881-1891



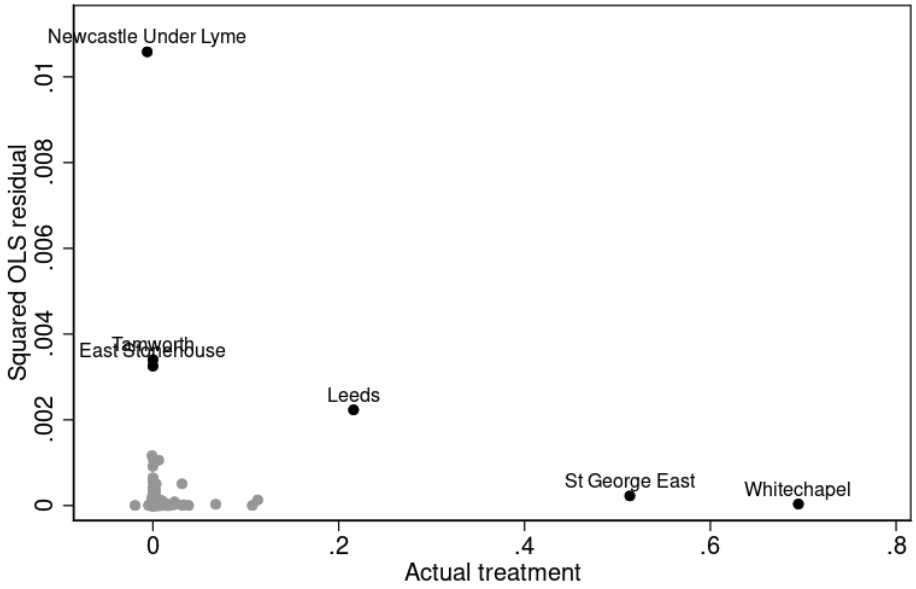
Panel B. 1891-1901



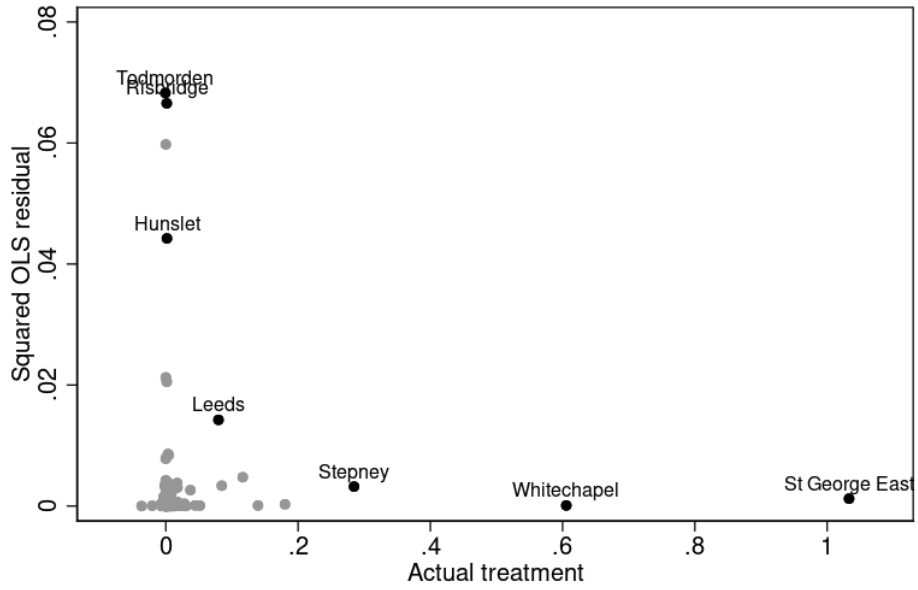
Notes: The horizontal axis reports actual Russian inflows into tailoring relative to the lagged broad English clothing base, while the vertical axis reports the corresponding fitted value from the first stage. Districts close to the 45-degree line are strongly predicted by the instrument.

Figure F.3: Squared OLS residuals and actual treatment

Panel A. 1881-1891



Panel B. 1891-1901



Notes: The figure plots squared OLS residuals against actual treatment. Districts with high treatment and relatively large residuals contribute disproportionately to OLS uncertainty.