

Farm Mechanization on an Otherwise 'Featureless'
Plain: Tractors on the Northern Great Plains and
Immigration Policy of the 1920s

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Abstract

Immediately following World War I, Canadian Prairie farmers adopted tractors more rapidly than did farmers on the U.S. Northern Great Plains. However, Canadian adoption rates lagged in the late 1920s. This change can be linked to a significant divergence in immigration policy; the US introduced restrictions while Canada returned to its prewar openness. The essentially homogeneous nature of this Plain on either side of the border sets up a natural experiment of the impact of immigration restrictions. We test the hypothesis using counties in the U.S. and Canada contiguous with the international boundary.

1 Introduction

It is well known that agriculture was transformed rapidly in the last fifty years and these transformations raised significantly the capital-labor ratio in agricultural production. Emblematic of this capital-labor substitution was the introduction of the tractor as the principal source of motive power. The tractor enabled farmers to dramatically increase their productivity because it allowed them to farm more land. As a result, average farm sizes in North America increased from about 140 acres in 1910 to over 400 acres today.

The resulting increase in agricultural labor productivity is readily apparent. The number of farmers in the U.S. peaked in 1910, then accounting for one-third of the workforce. In Canada, even as late as 1941, one-third of the male workforce was engaged directly in agriculture. Today, less than 3% of the labor force of Canada and

the US is employed in agriculture and that small labor force farms a land area only modestly smaller than it was at its peak. That so few can farm so vast a landscape resulted, in part, from the substantial scale effects from tractor usage.

The adoption of new technology may be affected both by market forces influencing commodity and factor prices, and institutional and political forces shaping the environment in which factor and commodity prices are determined. The adoption rate of the tractor in its initial phase responded surprisingly elastically to changes in factor markets resulting from reforms to legislation affecting institutions. Specifically, the influence of immigration policy had an observable impact on the diffusion of the tractor on the Northern Great Plains. The tractor is a labor-saving technology and as such, the value of the labor saved by its adoption depended on the expected supply of labor to agriculture. This labor supply was influenced by changes in immigration policy adopted during this period of the initial wave of tractor adoption.

Tractors were adopted initially in much greater numbers by farmers of the Northern Great Plains. But even among this geographically homogeneous group, adoption rates differed systematically across the region. Canadian Prairie farmers were particularly eager to adopt tractors initially. From World War I until the mid-1920s, Canadian Prairie farmers adopted tractors more rapidly than U.S. farmers on the Northern Great Plains.

In the second half of the 1920s, however, the geographical pattern of adoption rates was reversed and tractors were adopted more rapidly on the U.S. Northern Great Plains. What makes this oddity particularly interesting is that this change in adoption rates on either side of the border is coincident with changes to immigration policy in both Canada and the U.S. — changes that served to tighten labor supply in the U.S. but loosen it in Canada. This suggests that in responding to this policy change, the diffusion of this new technology was quite sensitive to labor market conditions.

The influence of labor market conditions on tractor adoption can be treated as a natural experiment of history. The differential changes to U.S. and Canadian immigration policy in the 1920s and their impact on labor markets can be considered the treatment. This treatment effect can be isolated due to the homogeneous nature of farms on the Northern Great Plains.

We examine the diffusion of tractors on the Northern Great Plains from Kansas through Alberta before and after the changes to immigration policy were implemented. To further control for systematic differences among regions, a very specific subset of counties lying contiguously on both sides of the border is isolated and the diffusion pattern examined. The results suggest that indeed U.S. and Canadian farmers on near-identical farms were influenced by differing labor supply conditions, and their responses differed in ways consistent with the labor conditions they faced.

2 Tractor Adoption on the Great Plains, on Both Sides of the International Border

The internal combustion engine was introduced into tractors only at the beginning of the twentieth century and initially the tractor was not particularly popular with farmers.¹ The first impetus to their diffusion was the labor shortage due to World War I. From World War I until the Great Depression, farmers in the U.S. and Canada adopted tractors enthusiastically. In 1915 there were 25,000 tractors on farms in the U.S.; by 1920 there were almost 250,000; and approximately 1 million were reported in 1930. As tractors were initially particularly well-suited for the prairie, farmers on the Great Plains were first to adopt. While only approximately 15% of farms in the U.S. had

¹They were very heavy, underpowered and had limited use in fieldwork other than plowing. They were used as a source of power for equipment.

adopted a tractor by 1930, on the Northern Great Plains the adoption rate was one-third (U.S. Bureau of the Census, 1931a).²

The Great Plains were best suited to tractor adoption in this period because farms were much larger on average. As well, because the frontier of new settlement was a grassland, farmers had potentially large farms free of trees from the outset. The use of a tractor increased the area of land a farmer could prepare and harvest within the seasonal constraint.

There is a sequence of steps necessary to growing crops and the timing of that sequence is defined by the seasons. Seeding takes place once the risk of frost has diminished. However, too long a wait to avoid late spring frosts increases the risk that poor fall weather will reduce crop yields before the crop has been harvested. The timing of spring preparation and fall harvest are linked by the time needed for crops to grow and ripen — approximately 98 - 135 days for Marquis wheat, the principal variety of spring wheat grown (Symko, 1999).

The use of a tractor sped up operations thereby allowing farmers to do more per season. Farmers could plow more land and plant more seed in the spring; and could then harvest the larger crop in the fall when it ripened. As a consequence of speeding up field operations, farmers using tractors had more time for additional work like raising livestock or providing custom work to other farmers (Martini and Silberberg, 2006)

As a tractor represented a fixed cost, a sufficiently large scale of operations was required to justify the cost of tractor purchase (Sargen, 1979; Clarke, 1994; Ankli, Helsberg, and Thompson, 1980; Lew, 2000). Farms of the Great Plains were large and

²These northern Great Plains states considered are Minnesota, North Dakota, South Dakota, Montana, Nebraska and Kansas. Nebraska and Kansas are not strictly similar to the other states as winter wheat is the principal small grain grown; whereas spring wheat is grown from South Dakota north. Nevertheless, techniques did not differ too significantly.

relatively homogeneous. Average farm size in 1920 was 140 acres for the entire U.S. while for the six Great Plains states average farm size was more than double at 330 acres. Canadian Prairie farms were even modestly larger, averaging 345 acres in 1921.

Farmers on the Canadian Prairies were initially relatively keen to adopt the new technology; and tractor adoption on the Canadian Prairies proceeded more rapidly than on the U.S. Great Plains after World War I. But that pattern persisted only until the mid-1920s. In the second half of the decade, adoption on the U.S. Great Plains accelerated, overtaking Canadian adoption rates.

Tractor adoption on the wheat belt is illustrated in Table 1 showing both average tractors per farm and the proportion of farms adopting tractors by state and province for 1920, 1925 and 1930.³ In 1920 and 1925, tractor adoption rates were higher for farmers on the Canadian Prairies than for farmers on the U.S. Great Plains. In 1920, Manitoba had the highest adoption rates — both in tractors per farm and in proportion of farms with tractors — followed by the Dakotas and Saskatchewan. Alberta lagged behind the leaders and fell slightly below average on both measures, but it was the most recently settled region. There was some shift in adoption rankings in 1925, but farmers in Saskatchewan and Manitoba along with those in North and South Dakota had still adopted most rapidly.

[Table 1 about here.]

By 1930 the rankings shifted quite dramatically. By both measures, all three Canadian provinces ranked lower than average for the wheat belt. Tractor adoption had advanced rapidly in Montana and the Dakotas. Whereas in 1920 and 1925, tractor adoption looked quite similar in Saskatchewan and North Dakota, by 1930 adoption accelerated

³Tractor counts are drawn from Census of the Prairie Provinces and the Census of Canada for Canada, and the Census of Agriculture for the U.S. Census dates will be identified as 1920, 1925 and 1930 in the text though the Canadian Census dates are actually for 1921, 1926 and 1931.

in absolute and relative terms in North Dakota. Montana, which was about average in 1920 and dead last in 1925, advanced to third behind North and South Dakota in 1930. And by 1930, Montana had substantially more tractors per farms and farms with tractors than did Manitoba or Saskatchewan. Kansas and Nebraska also increased tractor adoption rates surpassing the Canadian Prairie provinces by 1930.

These divergent patterns did not seem to be due to differences in farm policy. During the Great Depression, farm policy itself took sharply differing paths in the U.S. and Canada. New Deal policies, particularly the Agricultural Adjustment Act, played an important role in increasing tractor adoption in the U.S. (Clarke, 1994; Sorensen, Fishback, and Kantor, 2009). But during the 1920s, farm policy had yet to evolve into its modern form, despite increasing pressures for such changes.

Because of the postwar Depression and continued farm difficulties through the 1920s, there was growing political support for government intervention. In the U.S., price support and supply management policies were proposed in the McNary-Haugen bills passed by Congress in 1927 and again in 1928. However both bills suffered Presidential vetoes so neither became law. It took the effects of the Great Depression to bring about the implementation of the liberal policies like the Agricultural Adjustment Act.

In Canada, there was interest in addressing issues of farm credit, but otherwise there were no major policy initiatives, successful or unsuccessful.⁴ Ultimately there were no government policy initiatives directed specifically at agriculture in Canada or the U.S. during the 1920s that could have had an influence on tractor adoption.

While agricultural policy was yet to be fully interventionist, one large policy

⁴While farm foreclosures became much more frequent on the U.S. Northern Great Plain, they were not nearly as large a problem in Canada during this period. See Lew and McInnis (2007) for a discussion of this difference. For U.S. mortgage foreclosures see Alston (1983) and for farm distress during the 1920s see Johnson (1973/1974).

difference between Canada and the United States that could have differentially impacted agriculture was commercial policy. Tariffs in Canada on imported agricultural machinery were high, averaging almost 20%, and Canada imported much of its agricultural machinery, and all of its tractors in this period. However tractors valued under \$1400 were tariff-free beginning in 1918.⁵ As well, tariff rates on agricultural equipment were generally declining through this period.⁶ So while farm equipment in Canada other than tractors was more expensive due to the tariff, in response Canadian farmers likely substituted labor and land for machinery capital (Norrie, 1974). But tariff rates were falling through the 1920s. The falling tariff would serve to increase the relative rate of adoption of agricultural machinery by Canadian farmers even if the capital-labor ratio in agriculture in Canada was absolutely lower. Any finding to the contrary would be in spite of the decline in the tariff. And despite the falling tariff, Canadian Prairie farmers had adopted tractors more rapidly than Prairie farmers in the U.S. before 1925, and lagged behind them after 1925; exactly the opposite to the pattern otherwise expected due to the change in tariffs.

3 Immigration Policy Divergence and Farm Labor Supply

While there were no major initiatives aimed directly at agriculture, there were policy changes that had influence on agriculture more generally, and on tractor adoption specifically. The timing of one particular policy difference, immigration, appears to correlate perfectly with the change in rates of tractor adoption. It was in the 1920s that Canadian and U.S. immigration policy diverged; as the U.S. tightened, while Canada loosened immigration restrictions. The changes in immigration policy impacted

⁵The large majority of tractors adopted were in this category.

⁶Rates on many items fell; some rates remained essentially constant, but none increased (Phillips, 1956).

farmers' assessment of expected labor supply. Farmers in Canada anticipated continued inflows of labor while farmers in the U.S. realized labor supply would become increasingly inelastic.

Evidence of the impact of these diverging policy restrictions on the immigrant labor supply of the Great Plains is shown in Table 2. While the immigrant population of the Plains on the U.S. side of the border declined from 1920 to 1930 even while total population was increasing, in Canada the immigrant population increased.⁷ There was a different population dynamic on either side of the border.

[Table 2 about here.]

The shift in immigration policy came in a sequence of changes, and by 1925 the differences were in place. The U.S. introduced quotas on immigration with the Emergency Quota Act of 1921. Total immigration under the quota was set at 3% of the total number of foreign-born as recorded in the previous Census, which amounted to about 350,000. This was about a third of pre-quota annual immigrant inflows. But this quota was revised downward in the Immigration Act of 1924, reducing the annual flow by half again to about 165,000.⁸ In other words, over a period of four years, the immigration rate to the U.S. fell to 15% of its pre-quota rate. The quota was ultimately lowered further, to 150,000, originally to have gone into effect in 1927 but delayed until 1929.

Canadian immigration policy remained relatively restrictive in the early 1920s, but by 1925 had been relaxed in its application. And Canadian policy of the 1920s appeared similar to U.S. policy. Canada granted preferred access to Western Europeans

⁷Overall U.S. immigrant population size was increasing, albeit only modestly given the quota.

⁸Under the 1921 law, admission by national origin was based on each country's share in immigration in the Census of 1910. In 1924 the reference year was moved back the 1890 Census giving greater weight to Western Europe while reducing the base. This increased share of the quota for western European countries did not always get filled so the effective reduction of immigration exceeded the nominal reduction implied by the quota.

while restricting access to Southern and Eastern Europeans.⁹ But Canadian policy did differ significantly in that there was no total quota; overall immigration rates were left to the discretion of Cabinet (Green, 1995). And while the new policy explicitly discriminated against those from Southern and Eastern Europe — termed the non-preferred sending countries — there was a significant exception. Immigrants from non-preferred countries destined for agricultural work on the Prairies were admissible (Kelley and Trebilcock, 1998, p. 187-89).¹⁰ This exception became the core of a policy introduced in 1925 which was largely responsible for the surge in immigration in the latter part of the decade.

From 1925-30, under what was called the Railway Agreement, the Canadian government authorized the two Canadian railway companies to act as its agents in admitting immigrants.¹¹ The railway companies were given authority to screen and admit immigrants subject to the restrictions in place.¹² Essentially, they were allowed to recruit agricultural labor in Eastern Europe for the Canadian West. The overall effect of this policy was decidedly liberal; the decade of the 1920s turned out to be the period of the second largest immigrant inflow rate as a share of the resident population.¹³ The inflow of immigrants accelerated sharply after 1925 with the adoption of the Railway Agreement.

These policy changes affected the supply and destination choice of immigrants

⁹Canadian treatment of Asian immigration matched U.S. policy. It was already highly restrictive and therefore it is only European immigration policy that is relevant.

¹⁰There is a parallel clause in the U.S. policy in that agricultural workers were to be granted priority within a country's quota.

¹¹Avery (1995) argues that the railway agreement was introduced at the behest of capital to keep wages low. He is specifically identifying the resource extraction sectors. However, Green (1996, 1994) suggests that by providing a flow of labor to the prairies, farmers certainly would have benefited through higher land rents and lower wages.

¹²There was public suspicion that the railway companies were not adhering to the requirement that immigrants be admitted only if destined for the Prairies so that in 1927 the terms of the agreement were modified to require that immigrants provide explicit proof of employment in the West prior to admission.

¹³For Canada, the absorption rate, or ratio of immigrant inflows to resident population, in the 1920s ranks second only to the rate of the Wheat Boom era of 1896-1914.

to Canada. Eastern European immigrants were explicitly directed to settle in the Prairie West. During the earlier Wheat Boom era, only a minority of immigrants admitted had intended to settle in the Prairie West (Green and Green, 1993). But during the 1920s immigrant destination choice did shift to the Prairies. Evidence of this shift in destination choice implies an increase in the supply of labor to the Prairies. But it also appears that residence on the Prairies for many immigrants was only temporary.

The immigrant admissions data verify that as this policy was adopted and then implemented by the railway companies, there was an increase in the percentage of Eastern European immigrants reporting an intention to settle in the Prairies (Canada. Department of Immigration and Colonization, 1924/25 – 1930/31, 1920 – 1925). Panel A of Table 3 reports the distribution of immigrants who entered Canada via a port and reported an intention of settling in the Prairies by category of country of origin.¹⁴ The Prairies was the destination of choice of a little less than one-third of immigrants in the first half of the 1920s, and about one-half of immigrants by the latter half of the 1920s. More importantly, while British immigrants hardly shifted towards the Prairies, those immigrating from countries to which the Railway Agreements applied, shifted strongly to choosing the Prairies as their destination by the mid-1920s.¹⁵ But these data cannot be taken as evidence since most Eastern Europeans were admitted on the basis of this criterion.

[Table 3 about here.]

Evidence from the Canadian Census of 1931 as reported in Panel B of Table 3 can be used to reconcile the long-run response of immigrants' location choice. Panel B

¹⁴Countries of origin are classified as British if their citizens were considered to be British by the Canadian immigration authority. Preferred countries as those of Northwestern Europe as well as Finland. The countries to which the Railway Agreements applied were those of Central and Eastern Europe, but excluded Southern Europe.

¹⁵There was a modest shift of those immigrating from the non-British preferred countries, indicative of the gradation of restrictiveness being placed on immigration during this period.

reports proportion of immigrants residing in the Prairies in 1931 by category of country of origin, and by period of arrival (Canada. Dominion Bureau of Statistics, 1936). If there was a strong shift in the desirability of the Prairies as a destination, then immigrants arriving in the 1920s would be more likely to have remained on the Prairies. If, on the other hand, admission to Canada was predicated on a willingness to go to the Prairies upon arrival, then the immigration flow pattern will diverge from the settlement pattern reported in the Census at the end of the period.

For all immigrants regardless of origin, those arriving in the decade 1901-09 had the greatest propensity to settle on the Prairies. So despite the requirement during the 1920s that Eastern Europeans only be admitted if destined for the Prairies, and even though the immigration admission data in Panel A of Table 3 clearly illustrate that pattern, in fact immigrants from Eastern Europe had shown a greater tendency to settle in the Prairies during the prewar Wheat Boom era, when restrictions did not apply.¹⁶ So either Eastern European immigrants simply lied to gain admission, or many only remained on the Prairies temporarily.

Certainly this latter version jibes with what labor historians suggest. As well, the elasticities of the response of immigrants to population change reported in Table 2, highly elastic and negative in the U.S. states, and positive though rather inelastic in Canada, suggest that immigrants were highly mobile and remained only temporarily in the Prairies. Although we cannot be certain, the latter possibility seems likely, particularly after the imposition of the requirement that all immigrants admitted under the Railway Agreement obtain employment as a pre-condition of admission. This pattern implies a temporary flow of labor to the Prairies, presumably one into which

¹⁶For all other immigrants, the regional distribution from the annual admissions records and the settlement pattern from the 1931 Census are very similar. The patterns are consistent, regardless of whether the immigrants are from the British Isles, the preferred countries of Northwestern Europe, or even the non-preferred countries of Southern Europe.

farmers could tap when needed. That need, as will be discussed, turns out to have had strong seasonality which contributed to the temporary nature of migration through the Prairies.

4 Seasonal Labor Demand and Regional Labor Market

Integration

There are two features of agriculture on the Northern Great Plains that are relevant to the problem of labor market adjustment to agricultural labor demand: the seasonality of labor demand coupled with harvest volatility, and the remoteness from urban industrial labor markets. Both of these features complicate the labor supply available seasonally to the geographically remote Northern Great Plains.

Agricultural labor demand is highly seasonal, and its seasonality is most volatile on the Northern Great Plain. Farms on the Northern Great Plain were less diversified away from field crop production, and were even undiversified in the grain crops grown.¹⁷ That meant that labor demand peaked twice: once in the spring when the ground was being prepared and seeding was taking place, and even more strongly in the fall once the crop ripened. Delay at harvest meant increased risk of weather damage to the unharvested crop. But without much livestock, demand for labor during the rest of the year was much lower.

The seasonality of labor, along with the undiversified nature of the rural economy of the Northern Great Plains, precluded the availability of a local labor supply sufficiently large to accommodate the spike in demand at harvest. Temporary labor was essential, particularly at harvest when waiting meant an increased risk of crop damage.

¹⁷Generally the farther north and west the less diversified was farm output.

Because crop size varied with weather, long-range forecasting of labor demand was not possible. And harvest labor demand was rapidly increasing during the 1920s in the northwestern Great Plains — specifically Montana, Saskatchewan, and Alberta — due to increased settlement and increased wheat output.

Figure 1 illustrates the spike in labor demand on the Canadian Prairies during the harvest months of August and September.¹⁸ As a benchmark, labor demand is illustrated for the province of Ontario. Farming in Ontario is generally mixed so Ontario farm labor demand is less seasonal.¹⁹ Figure 1 illustrates the fundamental difference in the economics of agriculture on the Prairies. The spike in labor demand at harvest was on the order of ten times that of the demand during the rest of the year.²⁰ In contrast, there was only a very modest seasonality to the demand for labor in Ontario, the increase was not even a doubling, and the demand was spread over the full growing season.

[Figure 1 about here.]

Both the expansion of wheat production on the Northern Great Plains and its volatility are illustrated in Table 4. There is expansion of wheat production in almost all states during the 1920s, except in Nebraska and South Dakota; but the greatest expansions occur in Montana, Saskatchewan and Alberta. The bumper crop of 1915 is a useful comparator. In many of the states — Minnesota, Manitoba, North Dakota, and South Dakota — wheat output did not exceed the 1915 peak during this period.

¹⁸Data are from the Labour Gazette, reported monthly. These are job listings with the Employment Service of Canada, part of the Department of Labour, for employers needing labor. Data were only reported monthly by province beginning in October 1922.

¹⁹Ontario had approximately 80% the number of farms as the Prairies, but farms were smaller, with only about 30% of the improved acreage of the average Prairie farm.

²⁰There was demand for jobs categorized either as “personal service” or “household service” that had virtually no seasonal component and accounted for virtually all the demand for labor listed over the winter. The increase in labor demand at spring is also evident and was very modest relative to the harvest demand spike.

Montana had larger harvests in two years in the 1920s, but Saskatchewan and Alberta had larger harvests in six or more years during the 1920s.²¹ The larger harvests meant increased demand for harvest labor. There is also substantial yearly variation in harvest size. For example, in North Dakota the crop almost doubles from 1911 to 1912, then declines by one-third, remains constant for a year, then increases again by 60%. Volatility of crop size meant that harvest labor demand also varied substantially year to year.

[Table 4 about here.]

There was no formal system adopted to coordinate the geographic redeployment of labor to the harvest in the U.S. According to the traditional story, labor migrated north from Texas, following the progression of the harvest season up the latitudes. This supposedly provided sufficient employment to labor while meeting the labor demand spikes. While there was a small group of professional harvesters who made their living this way, the majority of workers were in fact from the industrial centers who took temporary employment as harvesters during the harvest season (Lescohier, 1922). As well, the seasonal migratory movement of labor itself was predominantly along east-west axes — from urban centers west into the wheat belt of similar latitude — not from south to north as the traditional story would have it (Lescohier, 1924, p. 19-21).²²

Labor market clearing worked to the extent that the supply of labor in the midwestern industrial centers was integrated with and matched the harvest demand on the farm. The labor supply choice of midwestern industrial workers was influenced primarily by factors more specific to their own industry and local to their region while

²¹ Acreage was increasing in Montana, Saskatchewan and Alberta during the 1920s, albeit less rapidly than before the 1920s.

²² This south-to-north pattern of migration became more apparent when the harvest was further mechanized with the introduction of the self-propelled combined harvester-thresher, or combine. During the 1940s, teams of combine operators migrated from Texas north following the grain harvest (Isern, 1981).

labor demand was highly volatile due to weather, and could differ dramatically within regions. (Lescohier, 1922, 1924)

In Canada, formal coordination of the movement of labor to the harvest on the Prairies was implemented in the 1890s with the introduction of the harvest excursion trains as an explicit response to the lack of surplus harvest labor on the Prairies (Thompson, 1978; Haythorne, 1933). Compared to the U.S., there was no easily accessible pool of urban industrial labor geographically near to the Canadian Prairie. Because of the recency of its settlement, the Canadian Prairies lacked large urban centers. Whereas both Minneapolis/St. Paul and Chicago are relatively near the Northern Great Plain states, there were no cities equivalent to Minneapolis or Chicago near the Canadian Prairie provinces. Winnipeg is the closest proxy for the Canadian Prairies, but with a population of only 220,000 in 1931 it was hardly the same urban labor pool as even Minneapolis/St. Paul with 750,000, let alone Chicago with over 4 million.

As an indicator of the importance of geography, the remoteness of the Canadian Prairie provinces and the U.S. Northern Great Plain States is illustrated in Table 5. A common definition of remoteness of location i from all other locations j is

$$r_i = \frac{\sum_{j \neq i} \text{dist}_{i,j} * \text{Pop}_j}{\sum_j \text{Pop}_j}, \text{ the population-weighted distance of location } i. \text{ }^{23}$$

[Table 5 about here.]

²³Distance is measured as the distance from the Prairie state/province to sources of labor, all urban centers in the country. Specifically, an urban center is defined as an urban area of 50,000 or more people. Data for U.S. urban centers are from the Censuses of 1920 and 1930, averaged over those two Census years. Data for Canada are from the Censuses of 1921 and 1931 and again averaged over the two Census years. Urban agglomeration is the basic unit used, so in some cases urban centers smaller than 50,000 are included where they are part of a larger urban area. An example is the quad cities of Davenport, Bettendorf, Rock Island and Moline none of which individually would make the 50,000 cutoff. The locations for the five states are taken as the geographic centers of the states ignoring population distribution across the state. The coordinates of the three provinces are not taken as the geographic centers because the northern half of the provinces include extensive uninhabited forest. Using the geographical center would exaggerate the remoteness of the Canadian Prairies. Instead the provincial coordinates are taken as the mean location between the two largest cities of each province. For Manitoba these are Winnipeg and Brandon; for Saskatchewan: Regina and Saskatoon; and for Alberta: Edmonton and Calgary.

Two measures of remoteness are reported using two alternate measures of distance reported in Table 5. The first measure uses simple great circle distances, and a second, alternate measure is adjusted to account for geography.²⁴ Using the remoteness calculated with great circle distances only, the Canadian Prairie provinces appear to be not much more remote from urban centers than do the U.S. Great Plain States. Even this may overstate the effective remoteness of the U.S. Great Plain states due to their distance from the large population centers along the East (and to a lesser extent in this period, West) Coast. The adjusted measure incorporates the effective greater distance from eastern Canada to the Canadian Prairie, and by the adjusted measure Saskatchewan and Alberta are very remote; only Montana is equally remote.

The remoteness measures are calculated assuming that the Canadian Prairies were not linked to U.S. midwestern labor markets. Had the border not mattered, labor should have been able to diffuse from midwestern urban centers throughout the Northern Great Plains.²⁵ Yet there is no evidence that labor demand on the Canadian Prairie was met by supply from the U.S. There is no mention by either Haythorne (1933) or Lescohier (1924) of cross-border labor flows. Farmers migrated in large numbers from the U.S. to Canada prior to World War I, but as homesteaders, not as laborers.

Fortunately, there is some direct evidence of the lack of cross-border harvest

²⁴In Canada, labor moving from east to west generally traveled through Toronto and on to Winnipeg before being dispersed across the Prairies and beyond to the West Coast. The great circle distance from Montreal to Edmonton would be a route through northern Ontario, appropriate for air travel, but not the rail route. To accommodate the geography of the trip, distances between eastern and western Canada are taken as the sum of the great circle distance from eastern origin to Toronto, the rail line distance from Toronto to Winnipeg (2074 km), and the great circle distance from Winnipeg to the western location. A similar approach is used for calculating distances between East and West for the U.S. where distance is the sum of the great circle distances between eastern origin and Chicago and great circle distance from Chicago to western destination for all origin points east of Chicago. Distances for points west of Chicago for the U.S., or north and west of Toronto for Canada are taken as the simple great circle distances because of the relatively few urban centers of the West, and the more general uniform geography of the West.

²⁵And immigrants to Canada should have been able to cross into the U.S. To avoid this problem, the Immigration Act of 1924 explicitly left open U.S. borders only to those having lived at least five years in their country of origin in the Western Hemisphere.

labor flows. In the early 1920s, the Canadian Department of Immigration reported specifically the movement of harvest labor across the Canada-U.S. border. (Canada. Department of Immigration and Colonization, 1920 – 1925, 1924/25 – 1930/31) The reports mention admission into Canada of approximately three- to four-thousand laborers from the U.S. in 1921 and 1922.²⁶ But the numbers decline to 655 harvest laborers reported entering from the U.S. in 1924; and there are no reported cross-border flows of harvest labor into Canada after 1924, just when the demand for harvest labor was increasing due to the increased size of the wheat harvests.²⁷ Had cross-border labor flows increased in the latter half of the 1920s, it would seem reasonable to assume the Department of Immigration would have reported them given that they are reported earlier in the decade.

Because of the much greater distance between urban industrial labor markets in eastern Canada and Prairie farms in western Canada, to assist with the matching of labor supply and demand, the railways, the Federal Government and the Prairie provincial governments coordinated the recruitment and movement of labor from eastern Canada and British Columbia to the Prairie provinces (Thompson, 1978; Haythorne, 1933).²⁸ The Federal Employment Service centralized job placements, assessed potential harvest conditions and organized excursion trains to move the expected number of harvesters.

The linking of western and eastern labor markets in Canada created additional problems.²⁹ Effectively, demand for labor by Prairie farmers was competing with

²⁶In 1923 the domestic harvest labor supply was supplemented with almost twenty-two thousand harvesters from the U.K. and the U.S. without a specific breakdown by country of origin.

²⁷Evidence cited by Isern (1981) indicates that very few combine teams moving up the latitudes in the 1940s continued across the border.

²⁸Haythorne's (1933, p. 536) data indicate that approximately 20% of labor demanded for the Prairie harvest was available locally through 1926. For 1927 - 1929 labor available locally increased modestly.

²⁹Coe and Emery (2004) provide evidence that Canadian labor markets were highly integrated during this period.

harvest labor demand throughout Canada, which because of geography tended to occur essentially simultaneously across Canada (Haythorne, 1933). This ultimately constrained the domestic capacity for Canada to expand Prairie settlement and drove the demand for immigrant labor. In the U.S., by contrast, the supply of agricultural labor from city to farm was largely an intraregional movement (Lescohier, 1924). Harvest labor demand was therefore met from industrial labor supplied within the general region.

In effect, the incentive for farmers of the Canadian Prairie to mechanize and save on scarce labor were greater than for similar farmers of the U.S. Northern Great Plains. Farmers on the Canadian Prairies lacked a local source of surplus harvest labor and had to compete for labor inter-regionally. And in response, Canadian Prairie farmers had indeed been more aggressively adopting tractors into the early 1920s. With demand for harvest labor increasing during the 1920s, even with the formal mechanisms for coordinating inter-regional movement of labor in place, supply of surplus seasonal labor sourced domestically could not keep pace. The Canadian response was to source immigrant labor — a reasonable solution in light of the large pool of available labor in Eastern Europe now excluded from the U.S. The adoption of an open immigration policy induced Canadian Prairie farmers to continue to rely on a inter-regional flow of harvest labor and thereby, relative to farmers in the U.S., delay further farm mechanization despite the otherwise greater incentive for them to mechanize.

5 Testing the ‘Featureless’ Plain Hypothesis

5.1 Immigration and Wages on the Prairies

The empirical strategy is first to establish that immigration had an impact on Prairie wages. The impact of immigration policy is hypothesized to have delayed adoption of capital-intensive farming methods — the use of tractors — by allowing farmers to substitute labor for capital where labor was available sufficiently reliably and inexpensively. The question to be addressed is whether or not factor prices were indeed affected by policies of immigration and therefore could potentially influence tractor adoption.

Green (1994) shows that immigration did impact Canadian Prairie farm wages for the period 1900-1930. He looked at Prairie farm wages as a function of the terms of trade and the immigration rate (immigration inflow per year divided by resident population over that period). This test is repeated here at the state and province level for the three Prairie provinces: Manitoba, Saskatchewan and Alberta; as well as the six wheat-growing states of the northern Great Plains: Minnesota, North Dakota, Montana, South Dakota, Nebraska and Kansas. Two variants are estimated:

$$\ln wage_t = \alpha + \beta imrat_{t-1} + \gamma \ln wheat\ price_t + \delta \mathbf{X}_t + \varepsilon_t$$

and

$$\ln \left(\frac{wage_t}{land\ price_t} \right) = a + b imrat_t + c \ln \left(\frac{land_t}{labor_t} \right) + d \mathbf{X}_t + \varepsilon_t.$$

The first variant models the Prairie farm wage rate as a function of the previous period’s immigration rate, the price of wheat, and a vector of other shift factors. It is well established that immigration responds to wage rate differences between sending

and receiving countries. So examining the wage rate as a function of the current period immigration rate should yield a positive relationship, as it does for these data.

Therefore, the hypothesis to be tested is whether immigration rates of the previous year lower wages in the year following.

Because of the importance of wheat-growing to the regions studied, rather than using the general terms of trade, wheat prices received by farmers at the state and province level are used. Other factors that might affect the wages in this period are the remoteness of the region and the War; both are included in the regressions.

The specification is extended to account for the endogeneity of wages and immigration. In the instrumental variables specification, the current period's immigration rate is instrumented using the previous period's immigration rate as well as a War dummy variable and remoteness. Remoteness is included as an instrument as distance may act as a barrier or cost to immigrants.

A second specification is also used, expressing the wage-rental ratio as a function of the land-labor ratio. This second form is chosen as Prairie wages behave rather similarly in the U.S. and Canada. Because of the higher immigration to Canada than to the U.S. in the later part of this period, the impact of immigration is likely to have differentially affected the price of the fixed factor, land, in Canada and the U.S. rather than only labor markets.³⁰

In this second specification, labor force is proxied by population size and land is area in farms.³¹ This specification is a useful test because all variables are in ratios so any distortions due to price-level and exchange rate effects are removed. In this

³⁰In Canada, the land endowment was expanding as frontier land was being brought into production. Nevertheless, there were estimates at the time of the potential area available for farming, a fixed constraint. In addition, in the short run, newer lands would likely be less desirable, farther from rail links, so would yield lower rents

³¹Land in farms is from Clifton and Crowley (1973) for the U.S. and Canada. Dominion Bureau of Statistics (1938) for Canada. Intercensus years are calculated by linear interpolation, which is the method used in Clifton and Crowley (1973) to derive the reported annual series.

specification, because the economy is open to immigration, the immigration rate is included as a shift factor. An increase in immigration should lower wages and increase land rents thereby reducing the ratio of wages to the price of land. So the hypothesized sign on the immigration term is negative if immigration had any impact on either labor markets or the value of land, or both.

Data used in these regressions are annual data for 1908-1930.³² All wages and prices are expressed in real 1913 \$US.³³ Immigration rates by state of intended destination are from U.S. Bureau of Immigration (various) and Canada. Department of Immigration and Colonization (1920 – 1925).³⁴ Regression results are presented in Table 6.

[Table 6 about here.]

All regressions are in first-difference form, so the regressions are explaining changes in the dependent variables. Both pooled regressions and fixed effects models are tested, with the state/province as the fixed effect. The OLS regressions in panel A include the lagged immigration rate and wheat prices, as well as several shift

³²Farm wages are the average annual monthly wages without board from U.S. Department of Agriculture (1951) and from Canada. Dominion Bureau of Statistics (annual) and Canada. Department of Agriculture (various).

³³US prices deflated using the BLS CPI Index, series Cc1-2 (Carter, 2006); Canadian prices deflated using Department of Labour Cost of Living index for 1913 on, and the Bertram-Percy index with missing years linearly interpolated using the Department of Labour's wholesale price index for years prior to 1913 (Urquhart, 1965). Base year is 1913. Canadian-US dollar exchange rate is from series H625 of Urquhart (1965). Land prices are from Clifton and Crowley (1973) and Canada. Dominion Bureau of Statistics (annual). Values reported in Canada. Dominion Bureau of Statistics (annual) include building values. Building values are subtracted using building values from the Census (Canada. Dominion Bureau of Statistics, 1938) linearly interpolated for non-census years.

³⁴Destination of immigrants in the period 1925-1930 is clearly distorted as reported in the Immigration Department reports, with a disproportionate number indicating Manitoba as destination. As immigrants from the non-preferred countries were admitted only for agricultural employment most of those indicating Manitoba were in fact using Winnipeg as a point to coordinate their employment elsewhere on the Prairies. Immigrant destination for these years in Canada are calculated as the total number of immigrants to all three Prairie provinces allocated according to the distribution of immigrant arrivals for this period as reported in the 1931 Census.

parameters. The coefficients on immigration for either the pooled or fixed effects model are negative and marginally significant, at the 10% level only. In the panel B wage-rental rate regressions, the coefficient on the lagged immigration rate is negative and marginally significant for the fixed effects specification, though not for the pooled specification. Coefficients on wheat prices are positive and significant and the WWI dummy variable coefficient is negative and significant. The year trend is also negative and significant. Immigration rates generally fall over the period. And while Canada does experience an increase in immigration in the second half of the 1920s, the overall immigration rate in this period is still lower than the pre-World War I era immigration inflow.

The instrumental variables regressions use lagged immigration as well as remoteness and the War dummy as instruments for current immigration. Because the instrument is for current period's immigration, not lagged, the coefficients on the immigration rate instrument are considerably larger than the coefficients on the lagged immigration variable in the OLS regressions. The instruments themselves are not reported in the results. Both pooled and fixed effect regression models are run with the instruments. In the instrumental variables regressions, the coefficient on the (instrumented) immigration rate is negative and statistically significant at the 5% level for both the pooled and the fixed effects models. These results hold for the instrumental variables wage-rental ratio regressions as well.

Taken in summary, there does seem to be evidence that immigration to the Prairies negatively affected Prairie farm wage rates. To directly test the impact of immigration policy on tractor adoption, tractor demand regressions will be used to determine if this labor market effect of immigration differences can be linked to the differential adoption rate of tractors in Canada and the United States during the 1920s.

5.2 State/Province-level Tests

The implications suggested in Table 1, that tractor adoption rates for the Canadian provinces fell off after 1925 reflecting the impact of changes in immigration policy, are tested using a difference-in-difference procedure. The treatment effect occurs in the latter half of the 1920s when U.S. immigration restrictions went into effect. The assumption underlying this model is that the treatment is the only significant difference between the two samples. While certainly there were differences between the two countries, it is maintained that none were of sufficient macroeconomic importance to have an effect on factor markets. And even if the tariff protection in Canada did induce farmers to substitute labor and land for capital, because the tariff rates were declining through this period, the difference-in-difference test is implicitly working against the bias of more rapid machinery adoption by Canadian farmers in the latter half of the 1920s in response to the decline in the tariff.

A demand function for tractors is estimated (Olmstead and Rhode, 2001). Tractor adoption is modeled as a function of the size of a farm specified as acreage in cropland per farm, and the price of inputs: tractors and fuel, and wages.³⁵

The estimating equation is as follows:

$$\begin{aligned} \ln \text{trac}_{i,t} = & \alpha + \beta_1 \ln \text{cropland}_{i,t} + \beta_2 \ln \text{tractor price}_{i,t} + \beta_3 \ln \text{gas price}_{i,t} \\ & + \beta_4 \ln \text{wage}_{i,t} + \beta_5 \text{foreignborn}_{i,t} + \gamma \mathbf{X}_{i,t} + \epsilon_{i,t}. \end{aligned}$$

where i subscripts state/province and t time, and $\mathbf{X}_{i,t}$ is a vector of possible Canada-specific and year-specific indicator variables, and their interactions.

³⁵Data for the U.S. generously provided by Paul Rhode. Gasoline prices are deflated by the CPI. Tractor prices are from White (2000) and for Canada from Canada. House of Commons (1937). Gasoline prices for Canada are from Canada. Dominion Bureau of Statistics (various) and interest rates from Canada. Dominion Bureau of Statistics (1948). Tractor prices are adjusted into real prices using data from White (2000). Farm wages are discussed above.

Two versions of the dependent variable *trac* are used: logarithm of tractors per farm, and the log odds ratio of tractor adoption defined as the logarithm of the ratio of the proportion of farms adopting tractors to the proportion of farms not adopting tractors. Input prices are the price of gasoline (*gas price*), the cost of tractor services (*tractor price*) calculated as the tractor price multiplied by the sum of the interest rate and the depreciation rate, and farm wages as discussed above. Immigration (*foreignborn*) is expressed as the number of immigrant arrivals divided by population. The 1920 and 1930 values are taken from the Census. There are no immigrant numbers reported in the mid-decade agricultural census. An estimate is made by taking the weighted average of the immigrant numbers for 1920 and 1930. The weighting is constructed using the annual immigration data by state and province of destination (Canada. Department of Immigration and Colonization, 1924/25 – 1930/31, 1920 – 1925; U.S. Bureau of Immigration, various).³⁶

Four variants of the above model are estimated and reported in Table 7.³⁷ The base model includes only the direct determinant of tractor adoption, farm size and input prices as well as the variable to be tested: immigrant share of population. This model is tested both in pooled form, as well as in a fixed effects form to account for differences among state and provinces.³⁸

[Table 7 about here.]

Regression models 1 – 4 are included to illustrate the impact of the factor prices on tractor demand. In the pooled OLS regressions 1 and 2, the coefficients on *cropland*

³⁶For Canada for 1926 - 1929 it is clear that immigrants were reporting their destination as Manitoba — specifically Winnipeg — if they were destined for farm work anywhere on the Prairies as the Western Canada Employments Service office in Winnipeg handled immigration destined for the Prairies. Therefore only a single Prairie weight is used for all three Prairie provinces.

³⁷Standard errors are adjusted for correlation of states/provinces over time.

³⁸For example, Nebraska and Kansas specialize in winter wheat, South Dakota grows both, and spring wheat dominates farther north. But there is even variation among states and provinces that specialize in spring wheat. More on this below.

are positive and significant. The coefficients on *tractor price* are negative and significant. While the coefficients on *wage* are incorrectly signed, they are not statistically significant. Coefficients on *gas price* have the wrong sign but are insignificant. The coefficients on *foreignborn* are negative and significant for the fixed effects models, but insignificant for the pooled regressions.

The difference-in-difference test is a test of a dummy, or in this case, period dummy, that distinguishes the treatment region from the control region. This test is shown in Table 7 as estimates numbers 7 and 8. Since the divergence in immigration policy occurred in the second half of the 1920s, the test is on the coefficient of the interaction *can*yr30* dummy variable. This interaction terms capture any effect specific to the Canadian sample in 1930. The test of the hypothesis is whether the *can*yr30* term is negative and significant. This hypothesis is maintained in both versions of the regressions using year dummy interaction variables. As well, the coefficients on *wage* are positive, but insignificant.

Because the sample size is rather small, three Census periods for nine states and provinces for a total of twenty-seven observations, a more parsimonious specification is provided in regressions 5 and 6 in Table 7. Here only a time trend and its interaction with the Canada dummy variable are used instead of two time-specific dummy variables and two Canada-dummy time-dummy interaction variables. In these specifications, the coefficient on *can* is positive and significant, and negative and significant on *can * year*. The interpretation is that Canada adopted more tractors initially, but then fell behind over time.

While in the previous section supporting evidence linking wages to immigration was reported, the link directly between wages and tractor adoption is weak. There is, however, evidence that immigration did matter directly to tractor adoption. The coefficient on *foreignborn* is negative in all specifications, and statistically significant in

most specifications. One reason that wages are not significant in the tractor demand regressions is that the wage data are imperfect; they do not capture the marginal cost to farmers. Rather, these are seasonal averages and typically for workers hired longer term. Not much can be done to address that issue without the availability of peak-time harvest rates consistent across regions.

It is possible that wages and tractor adoption are endogenous. This possibility is addressed using instrumental variables estimates. The instruments chosen for wages are the price of wheat and remoteness. The value of the marginal product of Prairie labor would have been determined by the wheat price as it was a principal output. And because wheat prices were determined internationally, activities on the Prairies could not have had much influence on international wheat prices. Remoteness of location also seems to have required employers to pay a premium.

The same four model variants using the two dependent variables are presented in Table 8. There are very few differences between the OLS and IV regressions: the coefficients on *foreignborn* have an increased level of statistical significance, but so too do the wrong-signed coefficients on *gas price* for the regressions using the year dummy variables. But as those regressions have few degrees of freedom left, the results may be less trustworthy despite the apparent significance.

In general, the input price covariates perform poorly, although almost never are their coefficients incorrectly signed and statistically significant, except for *gas price* in model 8 in Table 7, and in models 7 and 8 in Table 8. The coefficients on *tractor price* are always negative, and often statistically significant too. What is consistent are the signs on and significance of the coefficients on *foreignborn* and on the *can-year* interaction dummy. They are negative in all specifications, and statistically significant in almost all specifications. These results certainly support the hypothesis that adoption of tractors in Canada slowed relative to adoption in the U.S. in the latter half of the 1920s.

[Table 8 about here.]

5.3 Controlling for Heterogeneity Using County-level Data

It is possible to expand the dataset and to simultaneously better control for regional variation by drilling down to the county level. While wheat is grown across the Great Plains, this region is certainly not homogeneous; geography, climate and weather vary substantially across the Plains.³⁹ To control for geographic heterogeneity, data are analyzed for a small subset of this region: U.S. counties and Canadian census divisions bordering the forty-ninth parallel.⁴⁰ As the 49th parallel arbitrarily separates Canada from the U.S. without consideration for topography or geographic features, it will artificially divide regions that are geographically, climatically and agriculturally homogeneous. Therefore, differing outcomes for contiguous divisions on either side of the border will highlight the treatment effect of policy differences between the two countries.

Tractor adoption is illustrated in both 1925 and 1930 in Figure 2.⁴¹ The key feature of this figure is the obvious increase in tractor adoption in U.S. counties. Tractor adoption, which was more pronounced in the eastern Prairies in 1925 has clearly diffused west by 1930. But even with this increased diffusion, U.S. counties had adopted more rapidly.

[Figure 2 about here.]

In 1925, Saskatchewan Census Division 1 had more tractors per farm than did

³⁹For example, not only were Kansas and Nebraska relatively specialized in winter wheat, wheat crops in Kansas were ideally suited for the introduction of mechanized harvesting using combines. Farther north, crops took longer to dry and a higher content of green crops reduced the advantage of harvesting using a combine.

⁴⁰The Canadian prairie provinces are subdivided into census divisions.

⁴¹All figures illustrate categorization by quintile calculated over both years to keep the categorization consistent.

the U.S. counties lying immediately south, while Saskatchewan Census Divisions 2 and 3 had about the same number as the counties to the south. By 1930, all census divisions and counties had adopted more tractors, but all U.S. counties had overtaken all three bordering Saskatchewan census divisions. As well, most of the Manitoba census divisions had lost ground to counties in North Dakota. In the far west of the Prairies there is somewhat more variation. If, however, the Alberta Census Divisions 3 and 4 which do not border the U.S. but are otherwise similar are included, by 1930 tractor adoption rates in Montana drew even with and possibly exceeded tractor adoption rates in Alberta.

As tractors were better suited for larger farms on the Prairies, improved acreage per farm for 1925 and 1930 is illustrated in Figure 3 for the same set of counties and census divisions. Again, there is growth in improved acreage in most of the census divisions and counties, but the growth is relatively equal between Canadian census divisions and U.S. counties. Growth in improved acreage in Saskatchewan Census Divisions 3 and 4 matched growth in improved acreage in Montana counties Daniels, Valley, Phillips and Blaine. And growth in acreage in Alberta Census Divisions 1 and 2 outpaced acreage growth in Montana counties Hill and Liberty and matched acreage growth in Montana counties Toole and Glacier.

[Figure 3 about here.]

The state-level estimating procedure for tractor demand from above is repeated for these border counties. As tractor counts at the county level are not reported in the 1920 Census, these regressions are for 1925 and 1930 only.⁴² The test of the null hypothesis that there is no difference in tractor adoption rates between Canada and the U.S. is a test of the sign and significance of the *can*yr30* interaction dummy variable

⁴²Number of farms adopting by county are also not available.

coefficient.⁴³

There are forty-nine counties included and two years of data, so there are more observations available at the county-level, and therefore a bit more room to include more potential explanatory variables. As tractors are labor-saving, a farmer using tractors to prepare and harvest crops will therefore have more time available to manage livestock for a given farm size. Farms with more livestock may have less seasonal labor demand. So two measures of this labor demand are included: cattle per farm (*cattle stock*) and milk production per farm (*milk output*). Farms with livestock have higher labor demand. But among farms with livestock, those with more dairy cattle will have relatively higher labor demand as dairy cattle require greater attention. The inclusion of milk production captures the mix of cattle between dairy and beef. Tractor service prices (*tractor price*) and gasoline prices (*gas price*) are also used again, but are state-level constructs.

Counties differ somewhat in population densities (*pop density*) influencing the local labor market.⁴⁴ The variable of interest is the immigrant share of the county population (*foreignborn*). Foreign-born population is also interpolated for 1925, but using state-level weights described above to captures changes in inflow rates in the latter half of the 1920s. The foreign born population share is larger in Canada so the interaction term *foreignborn*yr30* captures the impact of the changed foreign born population share due to changes in policies in the second half of the 1920s.

To capture the treatment effect of policy divergence, the same difference-in-difference approach is used. Included are the *can* dummy variable, the *yr30* time dummy and the *can*yr30* interaction dummy. The null hypothesis is a test of

⁴³Cropland, milk output per farm, and cattle stock per farm, population density and foreignborn are all constructed from county-level data from the Census. Price data are state-level.

⁴⁴Because there is no population count in the U.S. Census of Agriculture of 1925, population is interpolated between the 1920 and 1930 Census years.

the sign and statistical significance of the coefficient on the interaction dummy term.

Estimates are presented in Table 9. Two different specifications are estimated. The pooled estimates are OLS regressions. An alternate form is used to capture additional regional variation. Geography changes along an east-west axis, but is relatively constant north and south of the international border. To capture this east-west geographical variation, a fixed effect defined by geographic zone is used.⁴⁵

[Table 9 about here.]

In pooled form, the coefficient on *cropland* is positive and significant while the coefficient on *cattle stock* is negative and significant. All prices behave as hypothesized. Coefficients on *tractor price* are negative and significant, *gas price* are negative and significant, and *wage* are positive and significant. The positive and significant coefficients on *wage* in particular are direct evidence of the link between labor markets and the demand for tractors. In regression 2, including the *can* dummy variable and the *can*yr30* interaction term, the coefficient on the interaction term is negative and significant. This is the basic difference-in-difference formulation. However, when *foreignborn* is included in regression 3, while the coefficient on the *can*yr30* interaction dummy variable remains negative, it is no longer significant. The coefficient on *foreignborn*yr30* is negative and significant, however. The interpretation is that Canada did not differ from the U.S. *per se*; rather, Canada differed in terms of a more open immigration policy and a greater presence of immigrants available.

⁴⁵The zones are defined as follows. Zone 1: Manitoba - Census Division (CD) 1, 5; Minnesota - Roseau. Zone 2: Manitoba - CD 2, 6; Minnesota - Kittson, Marshall; North Dakota - Pembina, Walsh. Zone 3: Manitoba - CD 3, 7; North Dakota - Benson, Cavalier, Ramsey, Towner. Zone 4: Manitoba - CD 4, 8; North Dakota - Bottineau, McHenry, Pierce, Rolette. Zone 5: Saskatchewan - CD 1, 5; North Dakota - Burke, Mountrail, Renville, Ward. Zone 6: Saskatchewan - CD 2, 6; North Dakota - Divide, Williams; Montana - Sheridan. Zone 7: Saskatchewan - CD 3, 7; Montana - Daniels, Roosevelt, Valley. Zone 8: Saskatchewan - CD 4, 8; Montana - Blaine, Phillips. Zone 9: Alberta - CD 1, 3; Montana - Hill, Liberty, Toole. Zone 10: Alberta - CD 2, 4; Montana - Glacier. These constitute the ten fixed effects.

With the inclusion of the fixed effects, coefficients on many of the covariates — *cattle stock*, *gas price*, *wage* — become insignificant, suggesting that geographic region is a stronger determinant of farmers' choice. However, the coefficient on *cropland* remains positive and statistically significant, and the coefficient on *tractor price* remain negative and statistically significant. As well, and most important, the coefficient on the *foreignborn*yr30* interaction term (in regression 6) remains negative and significant. Even controlling for geographic variation, the presence of a larger pool of immigrants is correlated with a reduced rate of tractor adoption. The maintenance, and indeed the expansion, of immigration inflow rates in Canada and their simultaneous reduction in the U.S. impacted diffusion of the labor-saving technology, the tractor.

As with the state-level analysis, the regressions in Table 9 are run using instrumental variables in order to control for potential endogeneity between the rate of tractor adoption and farm wages. Wages are instrumented using wheat prices and county remoteness. The results are reported in Table 10. Only the base and the full regression models from Table 9 are run using IV for brevity.

[Table 10 about here.]

The instruments may not be ideal as the coefficients on instrumented wages are all negative except for the fixed effects case 4, though none are statistically significant. The coefficients on *cropland* remain positive and significant. The coefficients on *tractor price* are negative but only significant for the fixed effects models. But, regardless of the model, the *foreignborn*yr30* interaction term coefficient is negative and significant. So even with the potential endogeneity in wages addressed, albeit weakly, a key determinate of tractor adoption is the relative immigration position of the two countries in the latter half of the 1920s.

6 Conclusion

As farming technique on the Great Plain states and provinces evolved under conditions of a flexible supply of labor available at demand peaks, changes in labor supply must have had a strong influence on the outlook of farmers. U.S. farmers were forced to change their expectations and substitute capital for labor. The dramatic increase in research and writing about the farmer's choice of tractor adoption during this period as Olmstead and Rhode (1994) review is certainly consistent with this changed outlook facing farmers in the U.S. By the mid-1920s, farmers in Canada felt less compelled to change their technologies as they realized they could rely on a flexible labor supply into the future due to the readoption of an open immigration policy by the Canadian government.

The diffusion of this new labor-saving technology did respond to policy affecting labor markets. We hypothesize that agricultural technique today may well be quite sensitive to labor markets conditions and changes in immigration policy and enforcement will likely result in changes in the capital-labor ratio in agriculture. The debate over immigration policy is particularly relevant to agriculture given agriculture's extensive reliance on unskilled, seasonal labor, most of which is supplied by migrants. It turns out that we have been down this path before. Prior to the diffusion of the combine and the virtually complete mechanization of harvesting, farmers were dependent on temporary labor for the harvest. Yet despite this reliance, the U.S. restricted immigration.

The result of the U.S. policy response can be judged against its counterfactual of restricted immigration. That counterfactual does not need to be theorized; it was adopted north of the forty-ninth parallel. After the U.S. imposed highly-restrictive immigration quotas, tractor adoption rates accelerated in the U.S., surpassing adoption

rates of Canadian farmers who had been the more enthusiastic and rapid adopters of this new technology in the early 1920s.

As there is otherwise no apparent difference in conditions facing farmers of the Northern Great Plains, and particularly for those farmers on either side of the international boundary, the timing of this accelerated adoption seems to be simply too coincident with changes in rules affecting the market for a principal input to farming in this region. The change to immigration policy in the 1920s was a dramatic shift in policy, and was implemented in such a way as to signal strongly that it was a permanent change. Farmers were able to adjust to the changes by accelerating their adoption of labor-saving technology.

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Table 1: Tractor Adoption: per Farm and Proportion of Farms Adopting Tractors, 1920, 1925, 1930

	Panel A								
	Tractors per Farm			Rank			Deviation from Mean		
	1920	1925	1930	1920	1925	1930	1920	1925	1930
Alberta	0.11	0.15	0.25	6	7	9	-0.01	-0.03	-0.09
Manitoba	0.19	0.23	0.27	1	2	7	0.06	0.05	-0.07
Saskatchewan	0.16	0.23	0.32	4	3	5	0.04	0.05	-0.02
Kansas	0.10	0.19	0.40	7	5	4	-0.02	0.01	0.06
Minnesota	0.09	0.14	0.26	9	8	8	-0.04	-0.04	-0.07
Montana	0.13	0.14	0.40	5	9	3	0.01	-0.04	0.07
Nebraska	0.09	0.15	0.31	8	6	6	-0.03	-0.03	-0.02
North Dakota	0.17	0.23	0.48	3	1	1	0.04	0.05	0.15
South Dakota	0.17	0.22	0.41	2	4	2	0.05	0.04	0.07
All	0.12	0.18	0.34						

	Panel B								
	Proportion of Farms Adopting Tractors			Rank			Deviation from Mean		
	1920	1925	1930	1920	1925	1930	1920	1925	1930
Alberta	0.10	0.13	0.23	6	8	9	-0.01	-0.03	-0.08
Manitoba	0.17	0.20	0.24	1	4	8	0.05	0.04	-0.07
Saskatchewan	0.15	0.20	0.29	4	3	6	0.03	0.04	-0.02
Kansas	0.10	0.17	0.36	7	5	4	-0.02	0.01	0.05
Minnesota	0.08	0.14	0.25	9	7	7	-0.03	-0.03	-0.06
Montana	0.12	0.12	0.36	5	9	3	0.00	-0.04	0.05
Nebraska	0.08	0.14	0.29	8	6	5	-0.03	-0.03	-0.01
North Dakota	0.15	0.21	0.44	3	1	1	0.04	0.04	0.13
South Dakota	0.16	0.21	0.37	2	2	2	0.05	0.04	0.07
All	0.11	0.17	0.31						

Source: U.S. Bureau of the Census (1931a, 1921a, 1925); Canada. Dominion Bureau of Statistics (1936, 1923, 1927).

Table 2: Immigrant Population, Northern Great Plains/Prairies, 1920 and 1930

Panel A						
	1920			1930		
	Population	Foreign Born		Population	Foreign Born	
Kansas	1,769,257	110,967	6.3%	1,880,999	80,897	4.3%
Minnesota	2,387,125	486,795	20.4%	2,563,953	390,790	15.2%
Montana	548,889	95,591	17.4%	537,606	75,903	14.1%
Nebraska	1,296,372	150,665	11.6%	1,377,963	119,199	8.7%
North Dakota	646,872	131,863	20.4%	680,845	105,871	15.5%
South Dakota	636,547	82,534	13.0%	692,849	66,061	9.5%
Alberta	588,454	273,364	46.5%	731,605	305,738	41.8%
Manitoba	610,118	222,372	36.4%	700,139	236,589	33.8%
Saskatchewan	757,510	299,677	39.6%	921,785	318,545	34.6%
US	105,710,620	13,920,692	13.2%	122,735,046	14,204,149	11.6%
Canada	8,787,949	1,955,736	22.3%	10,376,786	2,307,525	22.2%

Panel B			
	Percentage Change Population	Percentage Change Foreign Born	Elasticity - Foreign Born to Population
Kansas	6.3%	-27.1%	-4.3
Minnesota	7.4%	-19.7%	-2.7
Montana	-2.1%	-20.6%	10.0
Nebraska	6.3%	-20.9%	-3.3
North Dakota	5.3%	-19.7%	-3.8
South Dakota	8.8%	-20.0%	-2.3
Alberta	24.3%	11.8%	0.5
Manitoba	14.8%	6.4%	0.4
Saskatchewan	21.7%	6.3%	0.3
US	16.1%	2.0%	0.1
Canada	18.1%	18.0%	1.0

Source: U.S. Bureau of the Census (1931b, 1921b); Canada. Dominion Bureau of Statistics (1936, 1923).

Table 3: Proportion of Immigrants to Canada Choosing Prairie Destination, by Category of Country of Origin, 1921-1931

Panel A: Yearly Immigration				
	British	Preferred	Rail	South
1931	0.15	0.49	0.64	0.12
1930	0.23	0.56	0.70	0.15
1929	0.38	0.62	0.82	0.17
1928	0.31	0.59	0.79	0.18
1927	0.28	0.60	0.80	0.19
1926	0.24	0.65	0.79	0.19
1925	0.19	0.34	0.70	0.19
1924	0.24	0.30	0.54	0.18
1923	0.22	0.39	0.46	0.17
1922	0.29	0.54	0.36	0.17
1921	0.24	0.34	0.16	0.10

Panel B: Census Counts by Period of Arrival				
	British	Preferred	Rail	South
1926-30	0.25	0.36	0.49	0.07
1921-25	0.22	0.32	0.50	0.08
1916-20	0.26	0.52	0.38	0.09
1911-15	0.29	0.57	0.57	0.10
< 1911	0.29	0.59	0.69	0.10
1921	0.30	0.42	0.64	0.12

Source: Panel A: Canada. Department of Immigration and Colonization (1924/25 – 1930/31, 1920 – 1925). Panel B: Canada. Dominion Bureau of Statistics (1936) and last row from Canada. Dominion Bureau of Statistics (1923).

Table 4: Wheat Production by State/Province (millions of bushels)

	Kansas	Minne- sota	Mon- tana	Nebra- ska	North Dakota	South Dakota	Mani- toba	Saska- tchewan	Alberta
1905	78	57	3	47	99	43	56	26	2
1906	84	42	4	55	96	43	61	37	4
1907	76	45	5	45	69	33	40	28	4
1908	85	46	4	45	92	39	49	51	7
1909	77	57	6	48	117	47	46	90	10
1910	60	55	9	45	51	45	40	73	9
1911	57	41	16	40	79	17	61	97	37
1912	94	64	24	53	147	52	58	107	34
1913	87	60	30	60	97	33	63	112	34
1914	173	37	32	64	99	30	52	75	29
1915	106	62	61	70	159	60	97	215	67
1916	98	24	46	67	51	25	30	122	65
1917	43	46	29	12	62	44	43	118	53
1918	98	69	43	43	103	59	48	92	24
1919	153	37	8	58	61	31	41	90	35
1920	145	26	45	60	86	27	38	113	83
1921	134	23	42	60	88	26	39	188	53
1922	125	27	53	58	130	41	60	250	65
1923	84	24	49	32	69	27	36	272	145
1924	157	37	50	56	133	35	41	133	61
1925	81	30	35	33	114	32	34	241	98
1926	154	24	45	41	78	14	47	220	114
1927	114	21	82	72	134	48	31	253	171
1928	173	22	79	67	155	38	52	321	171
1929	156	21	41	55	100	35	29	161	90

Source: U.S. Data from U.S. Department of Agriculture (various); Canadian data from Wright and Davis (1925, p. 281) and Canada. Dominion Bureau of Statistics (1964).

Table 5: Remoteness of State and Province (km)

	Great Circle	Modified
Kansas	1516	1574
Minnesota	1421	1484
Montana	2401	2448
Nebraska	1576	1600
North Dakota	1802	1870
South Dakota	1681	1709
Manitoba	1593	2127
Saskatchewan	1940	2476
Alberta	2356	2897

See text for definitions.

Table 6: Impact of Immigration on Prairie Wages

Panel A: Farm Wage Rates				
	OLS		IV	
	Pooled	Fixed Effects	Pooled	Fixed Effects
<i>Immigration rate</i> _{<i>t</i>-1}	-1.0259*	-0.9918*	-5.2619**	-5.0683**
	[0.5578]	[0.4925]	[2.5172]	[2.4452]
<i>Wheat price</i>	0.0691***	0.0696***	0.0808***	0.0808***
	[0.0200]	[0.0126]	[0.0180]	[0.0182]
<i>Remoteness</i>	-5.9250	-33.9830***		
	[19.8615]	[8.2913]		
<i>WWI dummy</i>	-0.0387**	-0.0402***		
	[0.0188]	[0.0107]		
<i>Year</i>	-0.0023***	-0.0021**		
	[0.0008]	[0.0007]		
<i>Constant</i>	4.3685***	4.0666**	-0.0079*	
	[1.5872]	[1.4291]	[0.0042]	
<i>F</i>	3.85	5535.29	10.29	10.21

Panel B: Wage:Rental Ratio				
	OLS		IV	
	Pooled	Fixed Effects	Pooled	Fixed Effects
<i>Immigration rate</i> _{<i>t</i>-1}	-1.0828	-0.9618*	-7.2443**	-7.0301**
	[0.8428]	[0.5001]	[3.1519]	[3.0548]
<i>Land:Labor Ratio</i>	0.8642***	1.1298**	0.8130***	1.0375**
	[0.3205]	[0.3572]	[0.2754]	[0.3982]
<i>Constant</i>	0.0185*	0.0170***	0.0133**	
	[0.0101]	[0.0022]	[0.0056]	
<i>F</i>	4.25	8.63	14.03	11.91

*** represents significance at the 1 percent level.

** represents significance at the 5 percent level.

* represents significance at the 10 percent level.

Notes: Standard errors are in brackets, and are calculated robust to heteroskedasticity and autocorrelation.

Dependent variables in Panel A are \ln real wages, and in Panel B are $\ln \frac{\text{wage}}{\text{land price}}$. Data are for 1910–1930.

Sources: See text.

Table 7: State/Province-level Regression Results

	Pooled		Fixed Effects		Year Trend		Year Dummies	
	Tractors [1]	Adopters [2]	Tractors [3]	Adopters [4]	Tractors [5]	Adopters [6]	Tractors [7]	Adopters [8]
<i>cropland</i>	0.3666* [0.1868]	0.4377* [0.2104]	-0.1897 [0.1239]	-0.2513* [0.1306]	0.2754 [0.2138]	0.3529 [0.2421]	0.1535 [0.2875]	0.2146 [0.3095]
<i>tractor price</i>	-0.8398*** [0.1204]	-1.0606*** [0.1601]	-0.2798 [0.1565]	-0.3877* [0.1878]	-0.2891 [0.6358]	-0.7119 [0.7199]	-0.8556 [1.8263]	-1.0502 [2.0091]
<i>gas price</i>	0.6556 [0.8536]	0.8479 [1.0371]	0.6431 [0.5773]	0.9584 [0.7848]	0.7214 [0.4910]	0.9113 [0.5822]	1.4736 [0.8229]	1.7563* [0.8614]
<i>wage</i>	-0.0802 [0.4211]	-0.0573 [0.4899]	-0.7503 [0.4157]	-0.9217 [0.5031]	0.4140 [0.4829]	0.3945 [0.5245]	0.6364 [0.4426]	0.5766 [0.6189]
<i>foreignborn</i>	-0.0427 [0.1378]	-0.0823 [0.1674]	-0.8168*** [0.2296]	-1.0496*** [0.2755]	-0.2570* [0.1182]	-0.2877* [0.1385]	-0.4334* [0.2264]	-0.4866* [0.2451]
<i>year trend</i>					0.4466 [0.4169]	0.3492 [0.4568]		
<i>canada</i>					0.9182*** [0.2302]	1.1307*** [0.2277]	0.9738 [0.5625]	1.0692 [0.6339]
<i>can*year</i>					-0.2681*** [0.0559]	-0.3610*** [0.0658]		
1925							0.5016 [0.6660]	0.5076 [0.7162]
1930							0.4478 [2.0760]	0.5312 [2.2885]
<i>can*1925</i>							-0.7316 [0.4069]	-0.8329* [0.4433]
<i>can*1930</i>							-0.6327* [0.1918]	-0.7947*** [0.2023]
<i>constant</i>	2.8434 [3.3930]	4.0606 [4.1926]	1.9240 [2.8628]	3.3867 [3.8215]	-3.3606 [6.5471]	-0.6443 [7.3165]	1.0682 [12.1954]	2.5839 [12.9526]
<i>adj. R²</i>	0.75	0.78	0.93	0.93	0.84	0.86	0.84	0.86

*** represents significance at the 1 percent level.

** represents significance at the 5 percent level.

* represents significance at the 10 percent level.

Notes: Standard errors are in brackets.

Dependent variables are number of tractors per farm (Tractors), and log odds ratio of farms adopting tractors (Adopters). Sample size for all regressions: $n = 27$.

Sources: See text.

Table 8: State/Province-level Regression Results, Instrumental Variables

	Pooled		Fixed Effects		Year Trend		Year Dummies	
	Tractors	Adopters	Tractors	Adopters	Tractors	Adopters	Tractors	Adopters
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
<i>cropland</i>	0.3581** [0.1495]	0.4600*** [0.1588]	-0.0650 [0.2944]	-0.0129 [0.3830]	0.2769* [0.1629]	0.3627** [0.1805]	0.1547 [0.2043]	0.2148 [0.2281]
<i>tractor price</i>	-0.8383*** [0.1032]	-1.0645*** [0.1347]	-0.3349* [0.1779]	-0.4930** [0.2314]	-0.2627 [0.7119]	-0.5354 [0.7850]	-0.2737 [1.4398]	-0.9513 [1.5335]
<i>gas price</i>	0.7235 [0.6067]	0.6697 [0.7184]	0.2257 [0.6639]	0.1607 [0.8636]	0.6917 [0.5092]	0.7131 [0.5783]	1.6253** [0.6440]	1.7821*** [0.6579]
<i>wage</i>	-0.1541 [0.3911]	0.1367 [0.4740]	-0.2348 [0.6540]	0.0637 [0.8508]	0.4619 [0.8753]	0.7147 [0.9407]	0.0255 [1.1015]	0.4728 [1.2048]
<i>foreignborn</i>	-0.0507 [0.1024]	-0.0614 [0.1200]	-0.6997*** [0.2432]	-0.8258*** [0.3163]	-0.2586*** [0.0978]	-0.2987*** [0.1135]	-0.3964** [0.1789]	-0.4803** [0.2031]
<i>year trend</i>					0.4636 [0.4740]	0.4626 [0.5110]		
<i>canada</i>					0.9221*** [0.1591]	1.1568*** [0.1544]	0.7274 [0.5409]	1.0274* [0.5994]
<i>can*year</i>					-0.2669*** [0.0500]	-0.3530*** [0.0583]		
1925							0.5845 [0.4835]	0.5217 [0.4928]
1930							1.0340 [1.5910]	0.6308 [1.6870]
<i>can*1925</i>							-0.5578 [0.3882]	-0.8034* [0.4233]
<i>can*1930</i>							-0.5521*** [0.1728]	-0.7810*** [0.1578]
<i>constant</i>	3.2530 [2.6033]	2.9854 [3.1169]	-0.6589 [4.0466]	-1.5502 [5.2640]	-3.7963 [8.9434]	-3.5549 [9.7318]	0.2201 [8.8126]	2.4398 [9.3012]
<i>adj. R²</i>	0.75	0.78	0.94	0.93	0.84	0.86	0.83	0.86

*** represents significance at the 1 percent level.

** represents significance at the 5 percent level.

* represents significance at the 10 percent level.

Notes: Standard errors are in brackets.

Dependent variables are number of tractors per farm (Tractors), and log odds ratio of farms adopting tractors (Adopters). Sample size for all regressions: $n = 27$.

Sources: See text.

Table 9: County-Level Border-State/Province Tractor Demand Regressions

	Pooled			Fixed Effects		
	[1]	[2]	[3]	[4]	[5]	[6]
<i>cropland</i>	0.6203*** [0.0630]	0.6054*** [0.0743]	0.5985*** [0.0852]	0.7744*** [0.1069]	0.6689*** [0.1158]	0.6587*** [0.1227]
<i>milk output</i>	0.1581 [0.0990]	0.0354 [0.1199]	0.0051 [0.1053]	0.2413** [0.1153]	0.1525 [0.1471]	0.1234 [0.1305]
<i>cattle stock</i>	-0.2155** [0.0863]	-0.2684** [0.1061]	-0.2754*** [0.1001]	0.004 [0.1154]	-0.0848 [0.1209]	-0.1013 [0.1089]
<i>tractor price</i>	-3.9266** [1.6875]	-3.9362** [1.7523]	-3.3733 [2.2068]	-5.0300*** [1.8230]	-6.3963*** [2.1834]	-5.0158** [2.3411]
<i>gas price</i>	-0.5933* [0.3066]	-1.0721 [0.6782]	-1.3814** [0.6787]	0.5669 [0.4166]	0.9324 [0.9398]	0.4635 [0.9003]
<i>wage</i>	2.7593*** [0.8206]	2.9713*** [0.8844]	3.0147*** [0.8325]	0.6255 [1.0391]	1.0783 [1.1224]	1.2055 [0.9665]
<i>pop density</i>	0.0636 [0.0509]	0.1084** [0.0469]	0.1315 [0.0931]	-0.0513 [0.0484]	-0.0028 [0.0422]	0.0526 [0.0767]
<i>yr30</i>	-0.5956 [0.5780]	-0.4118 [0.5867]	1.3966 [0.8623]	-1.0216 [0.6353]	-1.3137* [0.7600]	0.4191 [0.9894]
<i>can</i>		0.3292 [0.3324]	0.2726 [0.3468]		-0.2312 [0.3477]	-0.1099 [0.3666]
<i>can*yr30</i>		-0.5748*** [0.1419]	-0.1872 [0.1912]		-0.2314 [0.1930]	0.0347 [0.2178]
<i>foreignborn</i>			0.0935 [0.0877]			0.0315 [0.0652]
<i>foreignborn*yr30</i>			-0.2181*** [0.0574]			-0.1703*** [0.0527]
<i>adj. R²</i>	0.69	0.75	0.76	0.79	0.82	0.83

*** represents significance at the 1 percent level.

** represents significance at the 5 percent level.

* represents significance at the 10 percent level.

Notes: Standard errors are in brackets. Dependent variable is number of tractors per farm. All variables in natural logarithms. Sample size for all regressions: $n = 98$. Constant and fixed effects (where included) are not reported.

Sources: See text.

Table 10: County-Level Border-State/Province Tractor Demand Regressions, Instrumental Variables

	Pooled		Fixed Effects	
	[1]	[2]	[3]	[4]
<i>cropland</i>	0.5236*** [0.0773]	0.5082*** [0.0981]	0.7554*** [0.0972]	0.5758*** [0.1329]
<i>milk output</i>	-0.0020 [0.1461]	-0.1454 [0.1542]	0.2349* [0.1267]	0.1194 [0.1285]
<i>cattle stock</i>	-0.1475 [0.1260]	-0.1891 [0.1442]	0.0602 [0.1270]	-0.0938 [0.1137]
<i>tractor price</i>	-0.9249 [2.1548]	-1.1408 [2.8919]	-4.7174** [1.9976]	-5.9300** [2.3459]
<i>gas price</i>	0.4210* [0.2182]	-0.1528 [0.7053]	0.9017*** [0.2423]	1.4730** [0.5905]
<i>wage</i>	-0.5080 [0.7268]	-0.0849 [0.7998]	-0.5337 [0.7491]	0.9822 [0.6829]
<i>pop density</i>	0.0362 [0.0688]	0.0948 [0.1274]	-0.0434 [0.0503]	0.0361 [0.0803]
<i>yr30</i>	0.3380 [0.7678]	2.0500* [1.0809]	-0.9651 [0.7254]	0.0664 [0.9632]
<i>can</i>		0.1422 [0.3930]		-0.4930 [0.3146]
<i>can*yr30</i>		-0.1339 [0.1754]		0.1365 [0.1914]
<i>foreignborn</i>		0.1069 [0.1126]		0.0260 [0.0710]
<i>foreignborn*yr30</i>		-0.2143*** [0.0507]		-0.1559*** [0.0517]
<i>adj. R²</i>	0.67	0.73	0.79	0.83

*** represents significance at the 1 percent level.

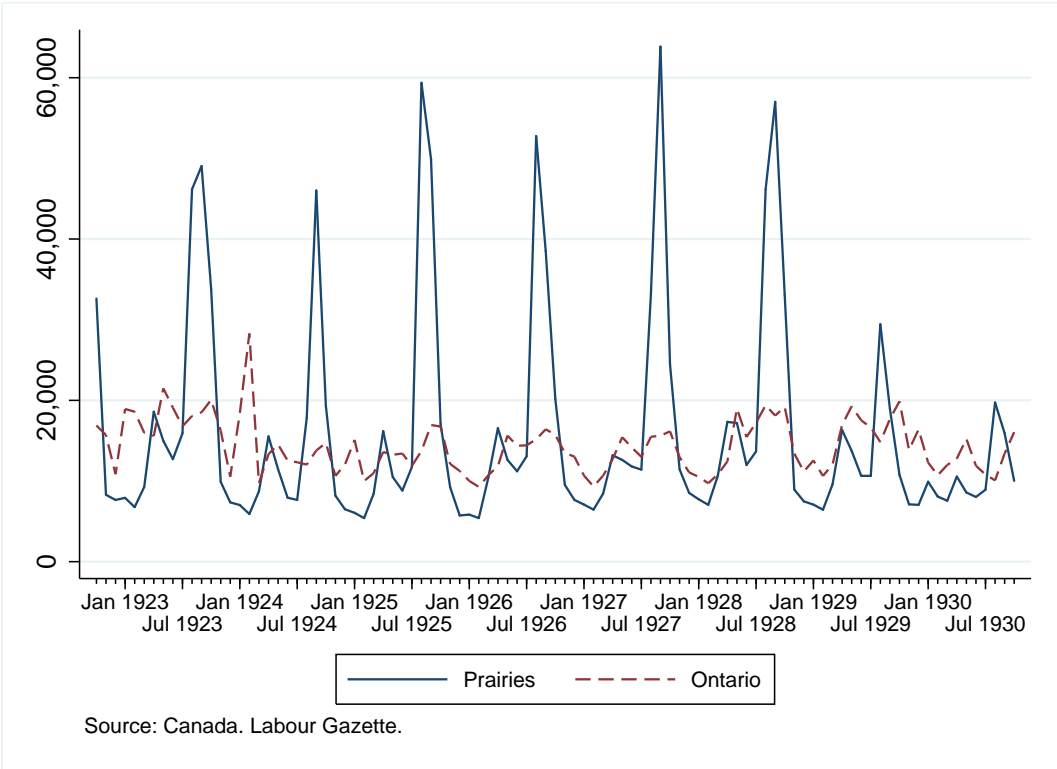
** represents significance at the 5 percent level.

* represents significance at the 10 percent level.

Notes: Standard errors are in brackets. Dependent variable is number of tractors per farm. All variables in natural logarithms. Sample size for all regressions: $n = 98$. Constant and fixed effects (where included) are not reported.

Sources: See text.

Figure 1: Job Vacancies (Monthly) Listed with Employment Service of Canada, Ontario and Prairie Provinces



Tractors per Farm

U.S. Counties and Canadian Census Divisions – Along 49th Parallel

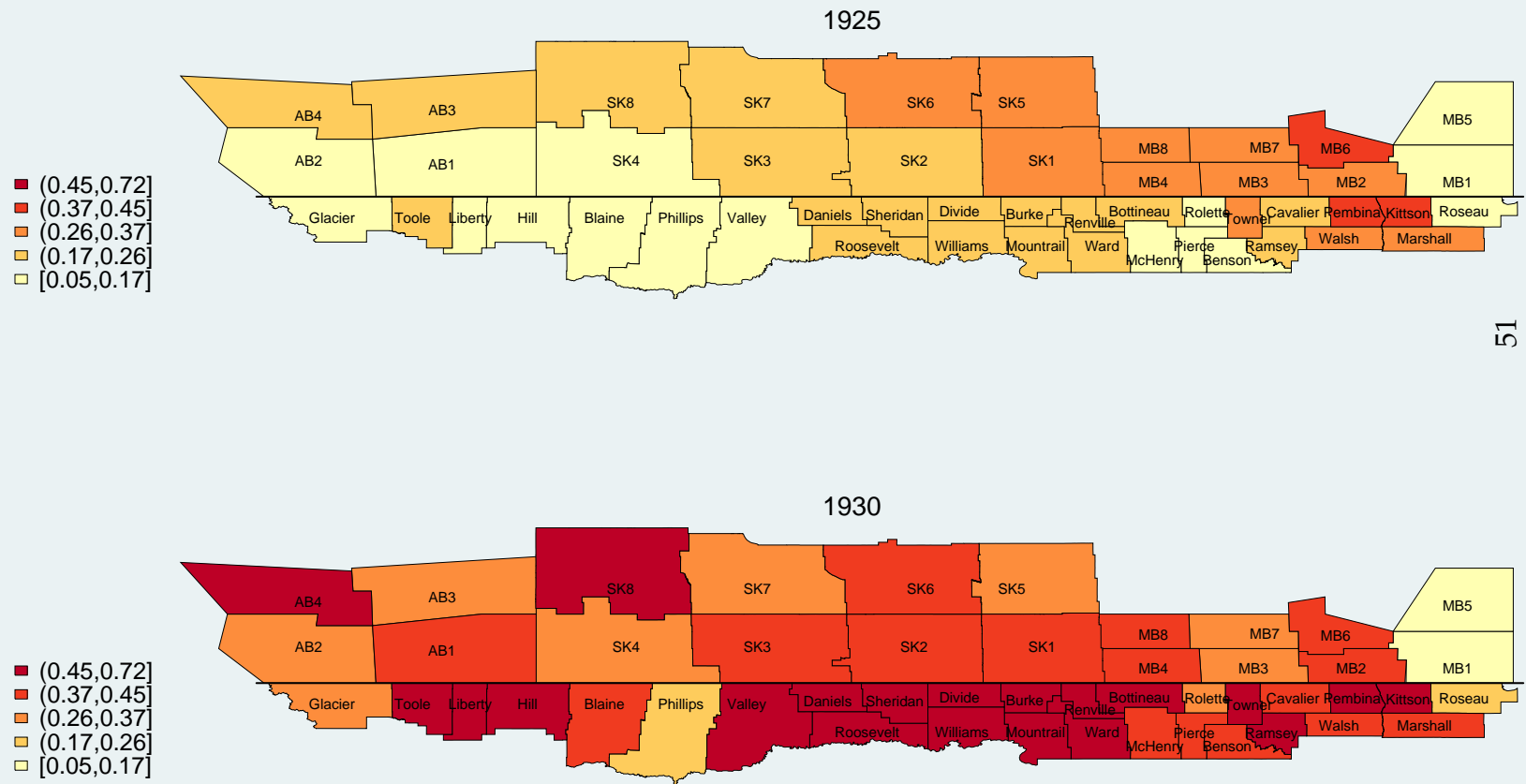


Figure 2: Tractors Per Farm, 1925 and 1930

Improved Acreage per Farm

U.S. Counties and Canadian Census Divisions – Along 49th Parallel

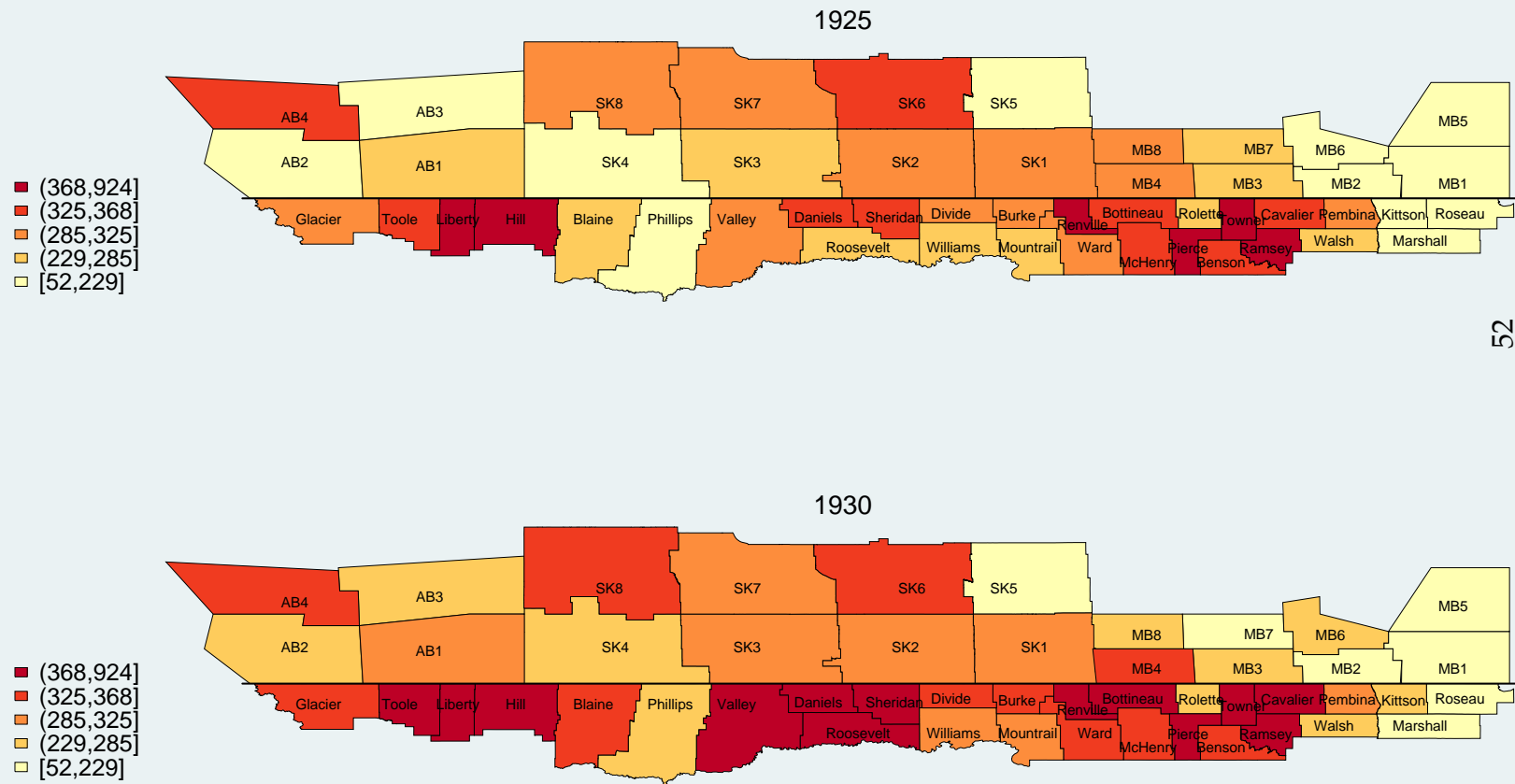


Figure 3: Improved Acreage per Farm