The Toll of Tariffs: Protectionism and the Education–Fertility Tradeoff in Late 19th century France*

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Abstract

The assumption that education and fertility are endogenous decisions that react to economic circumstances is a cornerstone of the unified growth theory that explains the transition to modern economic growth, yet evidence that such a mechanism was in operation before the 20th century is limited. This paper provides evidence of how protectionism reversed the education and fertility trends that were well under way in late 19th-century France. The Méline tariff, a tariff on cereals introduced in 1892, led to a substantial increase in agricultural wages, thus reducing the relative return to education. We use regional differences in the importance of cereal production in the local economy to estimate the impact of the tariff. Our findings indicate that the tariff reduced education and increased fertility. The magnitude of these effects was substantial, and in regions with large shares of employment in cereal production the tariff offset the time trend in birthrates for up to 17 years. We conclude that even in the 19th century, policies that changed the returns to the education of their offspring affected parents' decisions about the quantity and quality of children.

JEL Classification*:* J13, N33, O15

Key words*:* Education, fertility, unified growth theory, protectionism, France.

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1 Introduction

The causes of the emergence of modern growth remain hotly debated amongst economists. One of the most influential theories is unified growth theory (from now onwards, UGT), developed by Galor and Weil (1999), Galor and Weil (2000) and Galor and Moav (2002), which proposes a mechanism through which economies move endogenously from a subsistence Malthusian economy into a regime with growing per capita incomes. UGT builds on two key elements. On the one hand, technological change depends on population size and the level of education of the labour force. On the other, population growth and education are determined by household choices which respond to economic incentives. This second element implies a trade-off between the quantity and the quality of children that an individual has, with parents choosing between numerous but little-educated children or a few well-schooled offspring. Critics of UGT argue that it is unlikely that in the 19th century fertility and education were the outcome of rational choices, and that they were more likely shaped by social norms than by economic constraints.[1] The aim of this paper is to provide evidence for the fact that economic shocks affected fertility and education decisions well before the postwar period.

Our identification strategy relies on a major policy shock that occurred in France at the end of the 19th century. Following a massive increase in cereal exports that were arriving to Western Europe from the Americas and Russia, cereal prices in France plunged, resulting in a major income loss for cereal producers. As was the case in other European countries, political pressure to impose tariffs on cereal imports grew in the 1880s and led to the adoption in 1892 of the so called Méline tariff, a tariff that halted the fall in cereal prices and led to substantial wage increases (O'Rourke 1997). We argue that, under the assumption that human capital is less productive in agriculture than in manufacturing, the tariff reduced the relative return to education and, as predicted by UGT, led to a reduction in human capital investments and an increase in fertility. It is important to point out that we do not claim that the Méline tariff triggered the demographic transition in France, which had already taken place. Rather, we examine whether an economic shock affected quantity-quality choices at a point in history for which it is well established that households had taken control over their fertility decisions.

We construct a simple model that captures how a change in relative prices affects births and education. Our economy has two sectors, agriculture and manufacturing, and we suppose that human capital is productive only in the latter. Parents derive utility from both the number of children that they have and from the expected income of their offspring, which generates

[1] See Guinnane (2011), Diebolt (2015) and Clark and Cummins (2015) for a discussion.

the usual trade-off between fertility and investment in children's education. The latter is in turn determined by the relative return to education, that is, by the wage in manufacturing relative to that in agriculture and by the probabilities of being employed in one or the other sector. A tariff on agricultural goods increases wages in farming and the employment share of the sector, thus reducing the relative return to education and leading to lower investments in human capital. Because parents spend fewer resources in children's quality, they respond by increasing their quantity, and the tariff results in higher fertility rates. The larger the initial share of employment in cereal production, the stronger these effects are since the price increase implied by the tariff represents a larger shock to the local economy.

To take the model to the data we use France's division into administrative districts. In the late 19th century, these districts differed greatly in the importance that agriculture, and in particular cereal production, had in the local economy. We construct a proxy for employment in cereal production as a share of total employment for 1892 and interact it with a dummy taking the value one whenever the Méline tariff was in operation. We then examine the effect of the tariff on birth rates and fertility rates, and find a positive impact of the dummy interacted with cereal employment shares which is consistent with the theory. Education is measured by enrolment in primary education, which at the time catered for children aged between 6 and 13. Enrolment rates were negatively affected by the tariff, supporting theories that maintain that both education and births react rapidly to economic incentives, and that such responses took place even in the 19th century.

The paper contributes to the literature concerned with identifying the determinants of parental choices between fertility and education. The model introduced by Becker (1960) and enriched by Becker and Tomes (1976) has been the subject of numerous empirical tests. Most of this literature has used contemporary data and a variety of identification strategies, such as considering the impact of the arrival of twins in a household on subsequent education investments; see Rosenzweig and Wolpin (1980) or Rosenzweig and Zhang (2009) for more recent data. Broadly speaking, the evidence supports the existence of such a trade-off in the second half of the 20th century, although some results are less supportive (notably Black, Devereux, and Salvanes (2005) who argue that the impact of family size on education is in fact a relationship between birth order and education).

In contrast to the numerous studies on recent data, historical evidence on this trade-off is scarce, the exceptions being Becker, Cinnirella, and Woessmann (2010), Bleakley and Lange (2009) Diebolt, Mishra, and Perrin (2015), Diebolt, Menard, and Perrin (2016) and De La Croix and Perrin (2016). Our analysis shares much with these papers. Becker, Cinnirella, and Woessmann (2010) identify the quality-quantity trade-off using data for 19th century Prussia; they find suitable instruments for regional differences in education and fertility (sex ratios and distance to Wittenberg) and can hence identify the impact of one variable on the other. Our work is particularly close to Bleakley and Lange (2009) who use disease eradication in the south of the US around 1910 to analyse fertility and education responses. The exogenous campaigns to eradicate hookworm, a parasite that particularly affects children's health, reduced the "price of child quality" and thus increased the return to human capital. As a result, educational investments rose and fertility rates fell. We follow a similar empirical strategy by focusing on the relative return to education. In contrast to Bleakley and Lange (2009), the external shock we consider has a less direct impact on children's welfare and rather acts by changing equilibrium prices and quantities in the economy. What makes the strength of Bleakley and Lange's paper is also its drawback. Because it relies on a shock that has a direct impact on children's quality, the mechanism in operation is well identified, yet it does not provide evidence that aggregate macroeconomic features impact fertility and education as advocated by UGT. Our analysis focuses precisely on a major aggregate shock and identifies its consequences for fertility and education.

France is an interesting case to study, not only due to its rich historical data, but also because it was the first country to experience the fertility transition, well before any of the other early industrialisers, and four recent articles have used French district-level data similar to the one in this paper. Murphy (2015) explores the determinants of French fertility in the 19th century, and his findings indicate the importance of education, particularly that of females, but also of cultural factors in bringing about the fertility decline. Diebolt, Mishra, and Perrin (2015) and Diebolt, Menard, and Perrin (2016) are concerned with identifying the quantity-quality trade-off. Using a number of instruments, they find a trade-off between fertility and education and identify a causal impact of the former on the latter, thus providing evidence for the mechanism behind UGT. Furthermore, their analysis of gender differences in schooling indicates that the rise in female educational endowments played a role in the fertility transition, consistent with the findings in Murphy (2015). De La Croix and Perrin (2016) use the same data but take a different approach by building a detailed model of the determinants of education and fertility. As is the case in our paper, their approach is well-grounded in the theory but rather than using the latter to inspire a reduced-form estimation, as we do, they perform structural estimations aimed at quantifying to what extent observed patterns can be explained by rational choice rather than social norms. They estimate the deep parameters in the model and conclude that the rational-choice model can account for about a third of the fertility variation across districts and over time, while it explains between 71 and 83 percent of the dispersion of primary school enrolment. These three articles indicate the importance of the quantity-quality tradeoff in France during the 19th century. The contribution of our paper is to examine to what extent these decisions reacted to an aggregate economic shock.

A vast body of evidence has tried to identify the determinants of the demographic transition; see Easterlin (1976) for a discussion. Although our analysis is not concerned with this episode, since France had the world's earliest demographic transition which took place almost a century before the Méline tariff was introduced,[2] some of this literature proposes an approach closely related to ours by trying to identify variables that affect the cost of having children. Notably, Schultz (1985) argues that the fertility transition in Sweden, which took place in the 1880s, was largely the result of changes in international agricultural prices that raised the relative wage in female-intensive occupations. Exploiting differences across Swedish counties in the intensity of these activities, he finds that the increase in relative female wages explains a substantial fraction of fertility changes. Our paper shares with this work its emphasis on how terms of trade shocks that affect relative wages in a country can lead to rapid fertility responses.

Lastly, the paper is related to the economic history literature documenting the impact of late 19th century protectionist policy on economic outcomes. Following Bairoch (1972), numerous studies have found that protectionism was associated with higher growth rates and, when systematized to a panel of countries, this positive association between growth and tariffs has generated the so-called tariff-growth paradox; see O'Rourke (1997), O'Rourke (2000), Jacks (2006) and the survey in Lampe and Sharp (2013). Here we take a different approach; rather than exploiting cross-country differences, we document that *within* France the districts that benefited the most from the tariff were also those where it had the strongest negative effect on children's education.[3] The importance of trade for fertility and higher human capital accumulation has been explored by Galor and Mountford (2006) and Galor and Mountford (2008) who develop UGT open-economy models. They use recent cross-country data to test the models and find that while in the OECD a higher the share of trade in GDP is associated with lower fertility and human capital formation, it is positively correlated with fertility and negatively with education in non-OECD economies. Our analysis complements these results by focussing

[2]See Chaunu (1972), Van de Walle (1980), Weir (1984) and Bardet and Le Bras (1988) for evidence.

[3]Dormois (2009) uses industry-level data to document the negative impact of industrial tariffs on European industry.

on a policy variable rather than on trade shares, as well as by considering the question for the 19th century.

The paper is organised as follows. Section 2 gives the historical background of our study in terms of agricultural protectionism, education decisions and fertility. Section 3 solves a two-sector model of the joint family decision between the number of children and education. Section 4 presents the econometric specification we use to bring the model to the data. The next two sections present the data and the empirical results. Section 7 concludes.

2 Historical background

2.1 The Méline tariff and its economic consequences

The signing of the 1860 free-trade treaty with England has been viewed as a milestone in the historiography of French attitudes towards international trade (Bairoch 1972). Recent research argues that economic forces largely anticipated trade politics; see Nye (1991), Accominotti and Flandreau (2008), and Tena-Junguito, Lampe, and Tâmega Fernandes (2012). Nye (2007) shows that effective tariff duties on imports were low in France throughout the century, especially on agricultural products. The invention of the steamship and the development of the domestic railway network triggered a decrease of freight rates, especially across the Atlantic (North 1958 and Harley 1988) that increased grain market integration; see Federico and Persson (2007) and Uebele (2011). The resulting boom in trade was mainly driven by large exports of grains and other primary products from America to Europe which resulted in deflationary pressure on prices in France; see Kindleberger (1950). Agricultural prices declined more than other prices, thus reducing farmers' revenues, and generalised discontent led farmers to lobby for protection although, because of the alliance between free-traders and industrialists, no majority was obtained in Parliament to impose protective tariffs; see Dormois (2012).[4]

The 1889 parliamentary elections tilted the population of lawmakers towards a majority in favor of more protection. Negotiations with the governments and discussions in Parliament led to the proposal of an increase in the tariffs on cereals to fight the competition coming from the Americas.[5] Tariffs were introduced ad valorem: for each 100 kilos of cereals, the tariff increased

[4]Farmers' lobbying in the 1880s only led to the introduction of two different tariffs on wheat, depending on whether the country of origin of the product was granted the 'most-favored nation' clause or not. All of France's major trading partners were granted this clause, see Bassino and Dormois (1972).

[5]The tariff is named after Jules Méline, MP, several times agriculture minister and Prime Minister from 1896 to 1898. Méline, a staunch defender of agriculture, proposed to parliament the adoption of a tariff on cereals, which once adopted it became known as the "Méline tariff". Méline justified the the tariff by saying to lawmakers that "suddenly came the development of the means of transportation and communication, the rapid decrease in freight costs, in a few years placing these great markets [i.e. America, India and Australia] at our door"; quoted in Golob (1944, p.182)

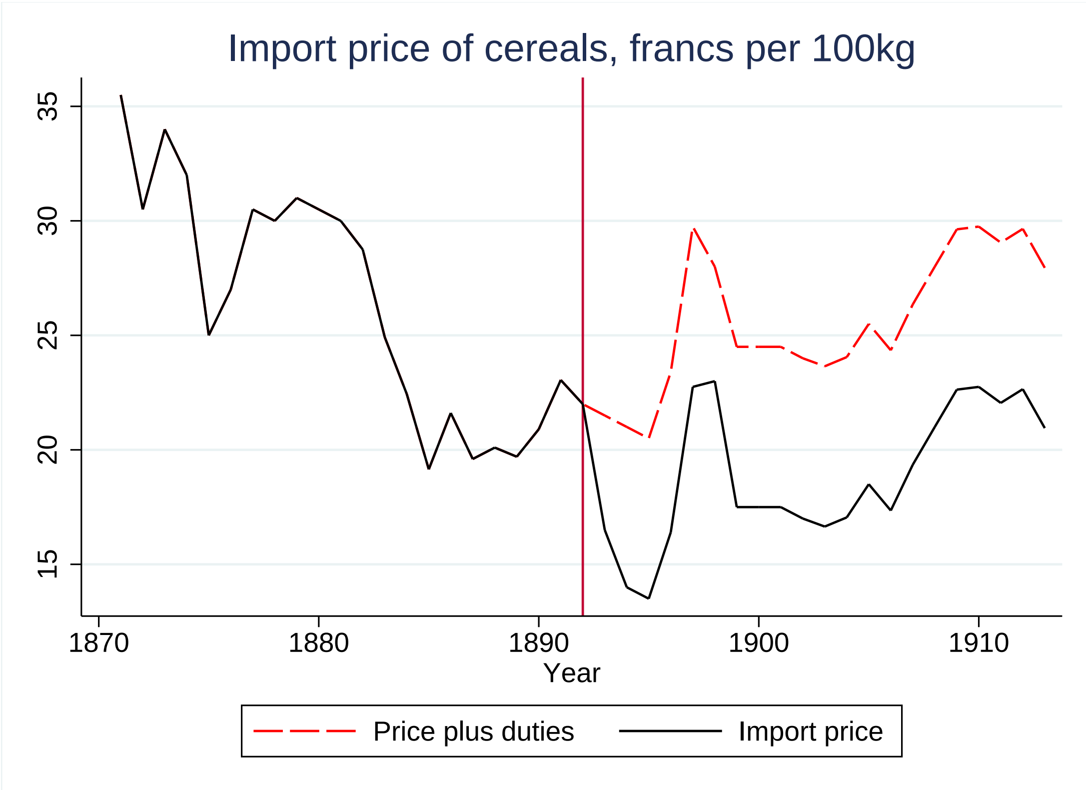


Figure 1: Cereal price in France, 1872-1913

the import price by 5 francs in 1892, which amounted to about 25% of the import price (see Figure 1 and Golob, 1944, p. 204). The economic magnitude of the tariff was substantial. Levasseur (1911, vol. II, p. 585) estimates that the Méline tariff, if applied earlier, would have increased the cereal prices in 1889 by 80%. Moreover, the law allowed for the tariff to be adjusted every year to take into account variations in the world price of cereals. According to Augé-Laribé (1950, p. 246-7) and Golob (1944, p. 234) there were thirty major legislative modifications of the tariff structure over 20 years. For example, in 1894 the wheat duty was increased from 5 to 7 francs per hundred kilograms, and in general was responsive to the underlying import price during the twenty years that followed the adoption of the Méline tariff.

Figure 1 depicts the evolution of the import price of cereals over our period of interest. Between 1871 and 1891 the import price of cereals had fallen by 35%, reaching a value of 22 francs per 100 kilos by 1892. The import price continued to fall in the years immediately following the introduction of the tariff, with the lowest price being reached in 1895. With an import price of 13.5 francs that year, the 7 franc tariff implied a massive increase in the market price of cereals. Over the following two decades, import prices fluctuated around 19 francs, with the duties increasing the price by an average of 37 percent and substantially stabilizing the

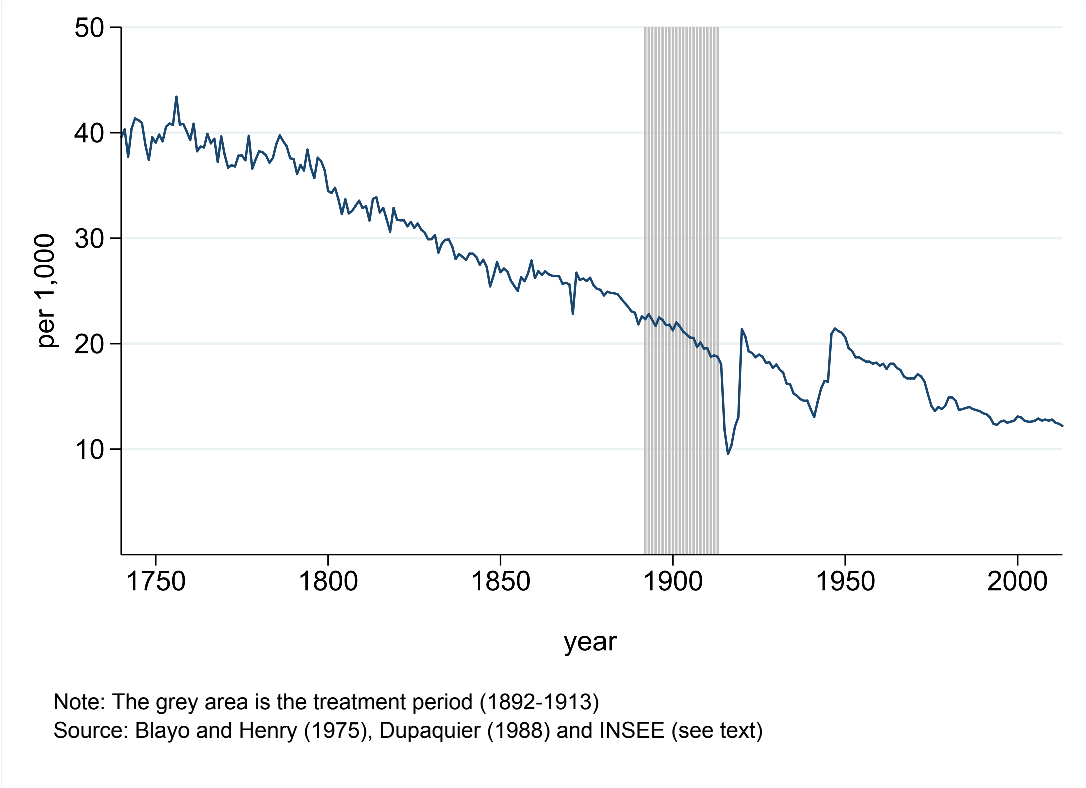


Figure 2: The birth rate in France 1740-2013

domestic price (Augé-Laribé 1950; Lhomme 1970).

The impact of the tariff was enormous. In a context in which the world price of grains decreased by a third, economist Daniel Zolla (1903, p. 26-33) noted that the tariff "succeeds in limiting the reduction in prices compared to England or Germany". For example, Zolla computes a price difference equal to half of the price in London for wheat (after 1892, the price levelled at 10 francs in England against 15 francs in France, cf. p. 28). Using a model that allows him to construct a counterfactual with free trade in cereals, O'Rourke (1997) documents that the Méline tariff protected farmers' revenue from most of this decline by increasing domestic prices by 26.5%. In a country in which the agricultural labour force represented 50% of the working population (Golob, 1944, p. 18), the tariff implied that actual French grain output was twice as large as it would have been in the absence of protection. The overall effect of the reduction in world prices plus the tariffs was an increase in the average real wages, largely driven by the wages of farmers who were made better off compared to the rest of the population (see also Zolla, 1903).[6]

[6]The impact of tariffs during the 19th century on wages and income is a complex question. See, for example O'Rourke (2000) and the survey in Lampe and Sharp (2013).

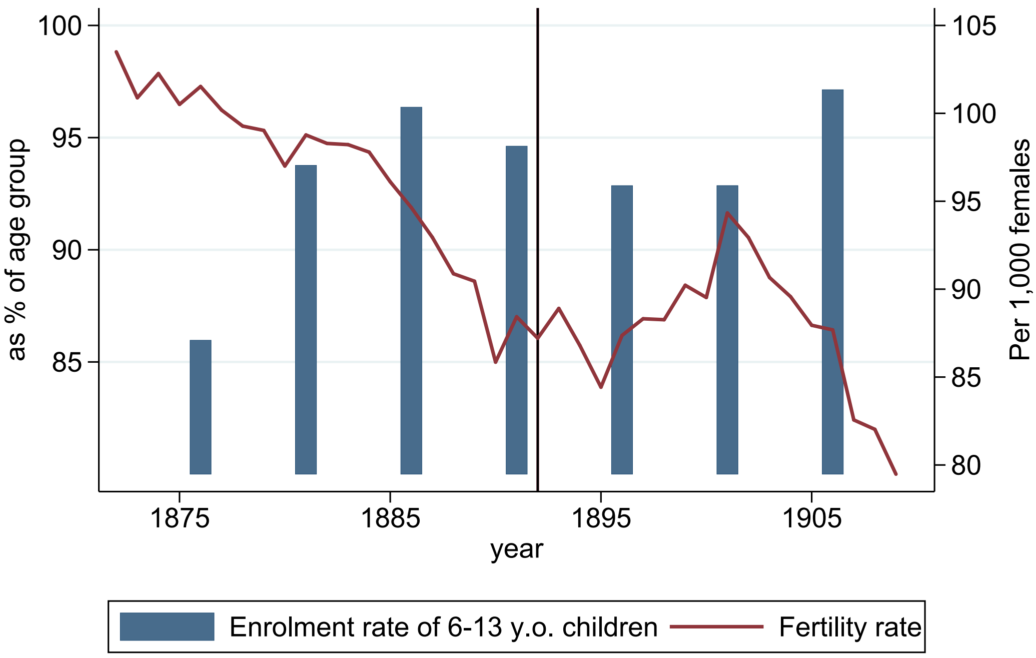
2.2 Education, fertility and the demographic transition in France

As it is widely acknowledged, France was the first country to experience a fertility transition; see Guinnane (2011) for a discussion in an international context. Figure 2 depicts the crude birth rate in France over the period 1740 to 2012, with our period of interest (1892-1913) shaded.[7] The first few years in the sample exhibit the usual pre-transition birth rate of around 40 children per thousand individuals. Birth rates started to decline around 1790, almost one century before the fertility transition took place in England and Germany. The reasons for this early transition are still not fully understood. It has been argued that the unique and spectacular reduction in mortality that took place in France in the second half of the 18th century could have been a trigger, while other authors have emphasised the role of wealth and the changes in inequality that followed the French Revolution; see Wrigley (1985a, 1985b), Guinnane (2011), and Cummins (2013) amongst others. In contrast to other countries where the late 19th century witnessed major changes in fertility behaviour, the period just before the introduction of the Méline tariff consists of two decades of substantial stability, with birth rates in France continuing their long–run decline, as can be seen from figure 2. There is nevertheless a slowdown of the trend after 1892. The birth rate fell by 2.5 children between 1872 and 1882 and by 1.9 children in the next decade (reductions of 1 and 0.75%, respectively), yet in the decade following the introduction of the tariff the birth rate declined by only 0.7 children (i.e. by 0.3%). Birth rates changed momentum after World War I, falling by 2.5 children between 1924 (the year in which the birth rate returned to its pre-war level) and 1934.

Figure 3 uses our district-level data to compute national aggregates for crude birth rates and enrolment rates (see section 4 for the details). The change in the birth-rate trend is apparent here. The rapid decline over the previous two decades comes to a halt, with birth rates increasing slightly just after the introduction of the tariff before declining again, although at a slower pace.

Turning now to schooling, the expansion of education in France took place in the middle of the 19th century, the result of major legal changes and a substantial investment in education infrastructure; see Prost (1993). Historians of education describe the period 1837-1867 as a period of "universalization" of primary education (Furet and Ozouf 1977; Grew and Harrigan 1991). The Guizot law of 1833 and the Duruy law of 1867 officially organised primary education by requiring any agglomeration of more than 500 inhabitants to open, respectively, a boys' and a girls' primary school, introducing a minimum wage for teachers, and facilitating access to

[7]Blayo and Henry (1975) is the source of the series before 1800. The 1946 INSEE statistical yearbook gives 19th century numbers, with the corrections proposed in Dupaquier (1988). The digitized series on the INSEE website are the source of figures for the 20th century.



The vertical line is the year of passing of Meline tariffs
Source: see text (data section and appendix 2)

Figure 3: The literacy and the fertility rate, France 1872-1913

schooling for the children of households that were unable to afford school fees. As a result, by 1881-1882, when the Ferry laws were introduced in order to implement compulsory and free private education, a majority of districts had attained enrolment rates close to one hundred percent. A puzzle in the literature is that of the "lost decade". Between 1886 and 1896 not only there was no progress in primary schooling, but many districts experienced a decline in enrolment rates, with the average falling by 3.9% and 4.4% for boys and girls respectively; see Prost (1993, p 71). The timing of these changes raises the question of whether the Méline tariff was one of the factors behind them.

Figure 3 presents our measure of education, enrolment rates in public and private primary schools, defined as number of pupils aged 6 to 13 enrolled over the total population of children aged 6 to 13 (see below for the details). Enrolment rates increased before the passing of the tariff, but the puzzle noticed by Prost (1993) is apparent, as the enrolment rate of children aged 6 to 13 decreased from 1891 to 1901, only to recover in 1906.

2.3 The returns to education

A key assumption underlying the mechanism that we will explore is that the return to human capital was higher in manufacturing than in agriculture in late 19th century France. Unfortunately, we have no direct measures of these returns as individual data on wages and education over the period are not available, but a number of elements point towards this being a reasonable hypothesis.

Data on education by sector of employment are scarce, and the earliest figures we have been able to find correspond to 1906. They indicate that lacking education was substantially more common amongst those working in agriculture than in manufacturing. In 1906, 18% of men in the agricultural sector were illiterate as opposed to 9% of those in industry; the difference is more marked for women, with the corresponding figures being 24% and 10%. Interestingly, there were major differences by category of employment. For unskilled male workers (*ouvriers*), 9% were illiterate in industry and 13% in agriculture, yet for those running a business/farm (*chef d'établissement*), the corresponding figures were 6% and 19%. In the case of women, workers were twice as likely to be illiterate in agriculture than in industry while 24% of agricultural heads of businesses were illiterate as opposed to 8% in industry. [8]

Table 1 presents evidence on the urban-rural wage gap during our period of interest, defined as the ratio of the nominal wages in the two types of location for salaried males. We consider wages paid for (unskilled) farm-related work as the nominal wages in rural areas. Wages paid to unskilled workers in urban areas are those paid in the capital city of the region. Table 1 presents two levels of aggregation of the wage gap. The finest level is at the *département* level. As a robustness check, we also present the wage gap between the capital city of the region (which grouped 4 to 5 *départements*) and the average paid in the countryside of the region. Lastly, we report the wage gap computed using wages averaged at the national level.

The wage gap at those three levels of aggregation exhibited a similar evolution. The regional figures indicate that there was a moderate gap of 10% around 1850, which grew sharply in the following decades and stabilized around 50% in the late 19th and early 20th century. The *département* data exhibits a lower wage gap, which is explained by the fact that wages in the *département* capital cities were on average lower than wages in the regional capital cities. The national data also shows a slow decrease in the wage gap after the introduction of the tariff. This large difference is difficult to justify simply by the cost of mobility and the cost of living, and is likely to have been due to differences in human capital across the two sectors.[9]

The likely explanation for the low educational achievement of the French agricultural labour force is the relative technological backwardness of the sector during the 1870–1913 period. Al-

[8] Own calculationd from data from the *Annuaire Statistique de la France*, 1910.

[9] See Chanut, Heffer, Mairesse, and Postel-Vinay (1995) for further discussion of wages in France in the 19th century.

	1852	1882	1892	1896	1900	1906	1911
Département	0.99	1.18	1.29				1.27
Regional	1.1	1.29	1.48				1.51
National			1.53	1.43	1.48	1.45	1.41

Source: Département and regional: Sicsic (1992, p. 685); National: Simiand (1931, table 1).

Table 1: The urban/rural wage gap ratios

though the reverse hypothesis has been proposed, explaining the low productivity of the agricultural sector by the lack of education of French peasants (Barral 1968; Weber 1976) or their low appetite for technological progress (Barral 1968), recent work maintains that it was due to the lack of agricultural investment (Postel-Vinay 1991; Grantham 1993; Postel-Vinay 1998). Male labour productivity in French agriculture was only 60% of that in England in 1880, and it had grown to 72% by 1910, a modest catch-up; see Bairoch (1965) as well as more recent studies (O'Brien and Keyder 2011). Dormois (1996) shows that during the 1890-1910 period, France had the fourth lowest average increase of agricultural productivity of the developed world, far behind Germany or the Scandinavian countries. The yield per hectare in wheat production was twice as low in France as in all other European countries except Russia and Italy (Bairoch 1989). Yet it is important to emphasize that this pattern was not prevalent in all of Europe, since in some countries technology had made rapid inroads into the agricultural sector, thus increasing the demand for educated farm workers.[10]

3 Modelling education and fertility decisions

In order to understand the way in which tariffs affect fertility and education investments, we consider a two-sector version of the quantity-quality trade-off model developed by Galor and Weil (1999) and Galor and Weil (2000) that abstracts from technological change. The production side of the economy features two goods, an agricultural good and a manufacturing good, both of which are traded. The later is the numeraire, while the agricultural good has an exogenously given price p_t that will be the source of the shock we consider. As in the original model, the key decision is the choice by households of the number of children and their education, i.e. their quantity and quality, in response to economic incentives.

[10]See Golob (1944) on the technological backwardness of French agriculture, O'Brien and Keyder (2011) on a comparison between France and England, and Henriksen, Lampe, and Sharp (2011) for a study of the Danish experience.

3.1 Technologies and preferences

The economy produces two goods, an agricultural good and a manufacturing good. The former is produced using land T and labour L_{at} according to the following technology

$$Y_{at} = (AT)^{1-\alpha} L_{at}^{\alpha}, \tag{1}$$

where Y_{at} is agricultural output, A is agricultural productivity, and $0 < \alpha < 1$. The manufacturing good is also produced through a Cobb-Douglas technology of the form

$$Y_{mt} = K^{1-\alpha} \left(h_t L_{mt}\right)^{\alpha}, \tag{2}$$

where Y_{mt} is manufacturing output, K is a fixed factor in the sector (potentially capital, but we abstract from its accumulation), h_t the average human capital of workers and L_{mt} employment in the sector. The price of the manufacturing good is 1, while that of the agricultural good is p_t. Moreover, since we are in a small open economy we suppose that $p_t = p_t^w(1+\eta_t)$ where p_t^w is the world price of agricultural goods and η_t is a tariff on those goods. The key assumption in the model is that human capital increases productivity in the manufacturing sector but not in agriculture. Although this is an extreme assumption, it is intended to capture in a simple way the idea that the return to education is higher in manufacturing.

The two sectors pay workers their marginal product, and in the appendix we derive the agricultural wage, w_{at}, and the wage per efficiency unit of labour in manufacturing, w_{mt}. Under our assumption that education has no impact on agricultural productivity, the income of a farmer is simply w_{at}. In contrast, human capital increases manufacturing productivity, implying that an agent with h_t efficiency units of labour receives a potential income of $h_t w_{mt}$. The fraction of the population employed in agriculture is denoted q_t and that employed in manufacturing $1-q_t$.

We turn next to households' preferences and constraints. Agents live for 2 periods, in the first one they are born and receive education from their parents, in the second they are adults and are endowed with 1 unit of time, which they may spend working or raising children. Borrowing across periods is assumed not to be possible.

We suppose that the utility of an agent born at time $t-1$ is given by

$$U_{t-1} = c_t^{1-\gamma} \left(n_t E y(e_t)\right)^{\gamma}, \tag{3}$$

where c_t is the consumption of the individual when she is an adult, n_t the number of children she has (which are born at t) and $Ey(e_t)$ the expected (potential) income that her offspring (with education e_t) will get when she is an adult, i.e. in $t+1$. The time cost of bearing n_t children is given by $\tau^q n_t$, while $\tau^e e_t n_t$ is the time cost of giving them a level of education e_t. The budget constraint is then given by

$$c_t = y_t(1 - (\tau^q + \tau^e e_t)n_t),$$

where y_t is the potential income that an individual born at $t-1$ has when she is an adult. We suppose that a constant fraction of consumption is allocated to the agricultural good and the rest to the manufacturing good.[11]

Adults whose parents invested e_t in their education have a level of human capital $h(e_t)$ with

$$h(e_t) = \beta e_t^{\theta}, \tag{4}$$

where $\beta > 0$ and $\theta \in (0,1)$, implying that $h(e_t)$ is increasing in e_t and exhibits diminishing returns to the education investment. When taking the education decision of their children, parents suppose that with probability q_{t+1} they will work in agriculture and with probability $(1 - q_{t+1})$ in manufacturing. The resulting expected potential income of an adult born at t is

$$Ey(e_t) = q_{t+1}w_{at+1} + (1 - q_{t+1})h(e_t)w_{mt+1}.$$

Clearly, the higher the agricultural wage and agricultural employment are, the lower the relative return to education will be, thus reducing the incentive of parents to forgo consumption in order to increase the education of their children. This mechanism will drive our results.

3.2 Solving the model

Education and fertility

The problem faced by an individual born at time $t-1$ is given by

$$\begin{aligned} \max_{n,e} U_{t-1} &= c_t^{1-\gamma}\left(n_t Ey(e_t)\right)^{\gamma} \\ s.t. \quad c_t &= y_t(1 - (\tau^q + \tau^e e_t)n_t) \\ y_t &= \phi w_{at} + (1-\phi)w_{mt}\beta e_{t-1}^{\theta} \\ h(e_t) &= \beta e_t^{\theta} \\ Ey_t &= q_{t+1}w_{at+1} + (1-q_{t+1})h(e_t)w_{mt+1} \\ e_t &\geq 0, n_t \geq 0, \text{ and } 1 - (\tau^q + \tau^e e_t)n_t \geq 0. \end{aligned} \tag{5}$$

The first two constraints give the consumption of the individual and her potential income, where ϕ is an indicator variable taking the value 1 if the individual works in agriculture and 0 if he

[11] It would be straight forward to derive such a result from a Cobb-Douglas utility function with two goods. We abstract from such decision in order to concentrate on the key aspects of the model. See Galor and Mountford (2006) and Galor and Mountford (2008) for models with an allocation of consumption over two goods.

works in manufacturing. The next constraint gives the human capital of the offspring followed by the expected potential income of an offspring. The last line gives the constraints that fertility, education investments, and consumption be non-negative.

The consumer's problem is solved in the appendix. There we show that the f.o.c. yield the following expressions for education and fertility

$$n_t^* \left(\tau^q + \tau^e e_t^*\right) = \gamma, \tag{6}$$

$$\frac{1-\theta}{\theta} e_t^* + \frac{q_{t+1} w_{at+1}}{(1-q_{t+1}) w_{mt+1}} \frac{(e_t^*)^{1-\theta}}{\beta\theta} = \frac{\tau^q}{\tau^e}. \tag{7}$$

The first equation is standard and gives the quantity-quality trade-off faced by parents, implying that any shock that reduces optimal education investments, e_t^*, results in an increase in fertility and vice versa. The second equation implicitly defines the optimal education investment as a function of the two wages and population proportions. This equation captures, as in Galor and Weil (2000), the fact that education investment in children depends on the way it impacts the expected wage of the offspring. That is, the education decision at t is determined by the return to education at $t+1$. The main difference with existing work is that investments in education will depend on the relative returns in the two sectors.

Before we fully solve the model, it is interesting to do some comparative statics with respect to q and wages. From the two equations above it is straight-forward to show that $\partial e_t^*/\partial q_{t+1} < 0$ and $\partial n_t^*/\partial q_{t+1} > 0$, implying that a higher agricultural employment share reduces education and increases fertility. The intuition for this effect is simply that since education has no value in the agricultural sector, a higher probability that one's children work in agriculture reduces the expected marginal gain of educating an offspring and hence will reduce parents' incentive to invest in their education. An increase in the relative wage in agriculture, i.e. a higher value of the ratio w_a/w_m, would have the same effect as an increase in agricultural employment.

The full solution to the model requires solving for wages and employment. Assuming no mobility costs, income is equalized across sectors and labour market equilibrium is given by the expression $w_{at}p_t = w_{mt}h(e_{t-1})$, which yields the equilibrium values of wages and employment.[12] We are interested in the impact of an increase in the price of the agricultural good, and in the appendix we show that a higher value of p increases the wage rate in agriculture, leading to a flow of labour into that sector. In order to simplify the analysis, we assuming that $\alpha = 0.5$,

[12]There is a long-standing debate about the degree of mobility of farmers in France and whether or not their reluctance to move choked industrial expansion. See Sicsic (1992) for a review of the literature and evidence of the comovement of agricultural and manufacturing wages. Our results would hold if we introduced costs of moving into manufacturing, with employment (wages) changes less (more) the higher these costs are.

which yields explicit analytical solutions so that we can write agricultural employment as

$$q_t = \frac{ap_t^2}{ap_t^2 + h(e_{t-1})}, \tag{8}$$

where $a \equiv AT/K$. A higher price of agricultural goods and a lower level of education increase employment in agriculture. If regions differ in the relative productivity of agriculture, they will also differ in their share of employment in agriculture. The higher the amount of land T or its productivity A are relative to the capital endowment K (i.e. the higher a is), the larger is the resulting q_t. Note that what is important for employment in agriculture is not whether agriculture is very productive, but rather whether it is very productive *relative to manufacturing.* It is hence possible for the regions that have the highest agricultural output per capita to have low shares of agricultural employment if they also have a very productive manufacturing sector.

From equation (7) we can see that the only magnitude that matters for education decisions is the ratio of the expected wage in the two sectors, which we denote ω. It is possible to show that in equilibrium

$$\omega_t \equiv \frac{q_t w_{at}}{(1-q_t)w_{mt}} = ap_t^2. \tag{9}$$

The expected relative return to agriculture is hence increasing in the price of agricultural goods p_t. This equation, together with (6) and (7) and the fact that $p_t = p_t^w(1+\eta_t)$, imply that the number of children and level of education are given by two functions

$$\begin{aligned} n_t^* &= n\left(e_t^*\right), \\ e_t^* &= e\left(p_{t+1}^w, \eta_{t+1}; a\right), \end{aligned}$$

where $n\left(e_t^*\right)$ is a decreasing function and $e\left(p_{t+1}^w, \eta_{t+1}; a\right)$ is decreasing in both p_{t+1}^w and η_{t+1}.

In a context of free trade (i.e. $\eta_t = 0$) and falling world prices of agricultural goods, these two equations imply that education will be increasing and the number of children falling over time. The intuition is straightforward. A lower price of farm products will reduce the agricultural wage for a given level of agricultural employment, hence labour will flow to manufacturing thus equating wages across sectors and reducing employment in agriculture. If parents at t expect a lower price next period, they will also expect a higher probability of employment in manufacturing for their offspring, which raises the return to education at $t+1$ leading to a higher investment in schooling at t. Since they now spend more time educating their children, parents choose to have fewer of them. As a result, falling world prices for agricultural goods will be accompanied by higher investment in education and smaller families.

Suppose now that a tariff is introduced at time t, i.e. $\eta_t > 0$, and that individuals expect it to be permanent, capturing the fact that the Méline tariff was perceived as a major change in regime, moving the French economy away from free trade. For any world price at $t+1$, the domestic price of agricultural goods will be higher than it would have been in the absence of the tariff. It is then possible to show (see appendix) that n_{t+1} will be higher and e_{t+1} lower than they would have been in the absence of the tariff.[13] Moreover, the difference in the two variables relative to their values had the tariff not been introduced will be larger the higher a is, i.e. the more important agricultural production is in the local economy. Since a higher a also implies that a greater share of population is employed in agriculture before the tariff is introduced, districts which have a high initial employment share in agriculture will be those experiencing the sharpest changes in our two variables of interest.

The model hence implies that a permanent increase in the tariff on agricultural goods leads parents to reduce the educational investment per child and to increase the number of children they bear, the effect being stronger the larger is the share of the population employed in agriculture before the policy shock.

3.3 The timing of children's education

The simple model we have considered cannot capture the full complexity of the dynamics of child-bearing and education decisions. In particular, a feature of our model is that if a tariff is introduced in year t, we would observe immediate changes in fertility and the children born after the tariff's introduction would receive less schooling than those of previous cohorts. The effect of the tariff on births would hence be observed immediately but that on education only once those children reached school-age. This raises the question of whether there are immediate effects on education or if these occur with a lag.

In order to examine more precisely the timing of education decisions, we consider an extension of the model and suppose that an individual lives for four periods. He is born at $t-2$ and in the next period is educated by his parents. For the following two periods he is an adult: he has children at t and educates them at $t+1$. The problem faced by an individual born at time $t-2$

[13] This does not imply that $n_{t+1} > n_t$ and $e_{t+1} < e_t$, as the evolution of the two variables also depends on how world prices are changing. The tariff simply results in an n_t (e_t) that is higher (lower) than that implied by the trend of agricultural prices in the absence of the tariff.

is then

$$\begin{aligned}
\max_{n_t,e_t} U_{t-2} &= c_{t+1}^{1-\gamma}\left(n_t Ey(e_t)\right)^{\gamma} \qquad (10)\\
s.t. \quad c_{t+1} &= y_t\left(\frac{1}{2}-\tau^q n_t\right)+y_{t+1}\left(\frac{1}{2}-\tau^e e_t n_t\right)\\
h(e_t) &= \beta e_t^{\theta}\\
Ey(e_t) &= q_{t+2}w_{at+2}+(1-q_{t+2})h(e_t)w_{mt+2}\\
e_t, n_t &\geq 0, 1/2-\tau^q n_t \geq 0,\ 1/2-\tau^e e_t n_t \geq 0.
\end{aligned}$$

This problem differs from the core model in the consumption constraint. There are now two terms, one for each period of adult life: at t some time is spent having children, at $t+1$ the parent educates them.

Assuming for simplicity that parental wages are constant and denoting the expected relative wage at $t+2$ by $\underline{\omega}_{t+2}$, we obtain the following expressions for education and fertility

$$\frac{1-\theta}{\theta}\underline{e}_t+\underline{\omega}_{t+2}\frac{(\underline{e}_t)^{1-\theta}}{\beta\theta}=\frac{\tau^q}{\tau^e}, \qquad (11)$$

$$\underline{n}_t\left(\tau^q+\tau^e_{t\underline{e}_t}\right)=\gamma. \qquad (12)$$

where $\underline{e}_t$ and $\underline{n}_t$ denote the solutions to the model when expected relative wage is $\underline{\omega}_{t+2}$. As before, a tariff will increase the relative return to agriculture which is now $\overline{\omega}_{t+2}$, higher than $\underline{\omega}_{t+2}$, resulting in $\overline{n}_t > \underline{n}_t$ children and a lower level of education, $\overline{e}_t < \underline{e}_t$.

Now consider the transition generation. At $t+1$, after the fertility decision is taken, i.e. for a given $\underline{n}_t$, a tariff is announced that will be in place from period $t+2$ onwards, so that the relative return to education is $\overline{\omega}_{t+2}$. Parents will reoptimise their education decision in response to the change in the relative return to education and maximize $U_{t-2}=c_{t+1}^{1-\gamma}\left(\underline{n}_t Ey(e_t)\right)^{\gamma}$, that is, choose education taking the number of children as given. It is possible to show that the solution to the new problem is given by

$$\frac{e_t}{\theta}+\underline{\omega}_{t+2}\frac{(e_t)^{1-\theta}}{\beta\theta}=\frac{1}{1-\gamma}\frac{\tau^q+\tau^e_t\underline{e}_t}{\tau^e}-\frac{\gamma}{1-\gamma}\frac{\tau^q+\tau^e e_t}{\tau^e}, \qquad (13)$$

which implies a level of education e_t different from $\underline{e}_t$. Two effects are in operation: the lower return to education will tend to reduce education, while the fact under the new returns parents optimal fertility is $\overline{n}_t$ but they have only $\underline{n}_t$ children implies that they will tend to compensate their suboptimal fertility by educating their children more. It is possible to show that either effect could dominate. As a result, the change in the return to education following the tariff implies that parents will increase or reduce education even for children that were born before the tariff was implemented, i.e. the effect on education can be immediate and does not occur only once those born after the tariff is introduced reach school-age.

4 Econometric specification

Inspired by the model above, our empirical specification consists of the following two equations:

$$B_{it} = \alpha_0 + \alpha_1 S_i * M_t + \eta_i + \delta_t + \delta_{1i} t + \delta_{2i} t^2 + \epsilon_{it}, \quad (14)$$

$$E_{it} = \beta_0 + \beta_1 S_i * M_t + \mu_i + \gamma_t + \delta_{3i} t + \upsilon_{it}, \quad (15)$$

where B_{it} and E_{it} are respectively birth rates (or fertility) and education in department i at time t. We introduce district fixed effects (η_i, μ_i) and year fixed effects (δ_t, γ_t), while the coefficients δ_{1i} to δ_{3i} capture the impact of district-specific time trends affecting fertility and education. We allow for quadratic time trends when we have annual data but only linear ones whenever we have only quinquennial census data. M_t is a dummy for whether the Méline tariff is in operation at time t and S_i is the local share of employment in cereal production in the year in which the tariff is introduced. This variable hence acts as a proxy for the capacity for cereal production, and thus the larger S_i is, the stronger we expect the effect of the tariff to be. Note that we cannot identify the non-interacted effect of the variables M_t and S_i, as the impact of the former cannot be distinguished from that of the year fixed-effects and the latter is collinear with the district fixed effects.

Our coefficients of interest are thus α_1 and β_1, which capture the differential impact of the tariff across districts with different degrees of cereal production. Unified growth theory predicts a trade-off between fertility and education so that the coefficients α_1 and β_1 are of opposite sign. The model above implies that the tariff acts a negative shock to the returns to education, leading to higher fertility and lower education, so that we expect $\alpha_1 > 0$ and $\beta_1 < 0$.

The time structure of the impact of a policy is crucial, as discussed by Wolfers (2006). Although the effect of the tariff on prices is immediate, fertility and education are likely to respond with a lag because wages may adjust slowly and bearing children and educating them take time, but also because both variables are affected by social norms resulting from past behaviour that may slowdown the reaction to policy. We will thus consider two further specifications for each of our dependent variables. For birth rates, the first one takes the form

$$B_{it} = \alpha_0 + \alpha_1 M_t * Exp_t + \alpha_2 S_i * M_t * Exp_t + \eta_i + \delta_t + \delta_{1i} t + \delta_{2i} t^2 + \epsilon_{it}, \quad (16)$$

where Exp_t denotes the number of years of exposure to the policy, and we expect the coefficient α_2 to be positive, indicating that households take time to adjust their fertility to the policy.[14] An alternative specification, based on Wolfers' analysis of divorce laws, allows for a different impact of the tariff in different years, that is,

$$B_{it} = \alpha_0 + \alpha_1 S_i * M_t + \sum_{k>1} \alpha_k S_i * M_t + \eta_i + \delta_t + \delta_{1i} t + \delta_{2i} t^2 + \epsilon_{it}, \tag{17}$$

where α_1 is the initially effect of the policy and α_k indicates the excess impact that occurs after k years. This specification gives greater flexibility when estimating the impact of the policy, allowing, for example, for the possibility that there is a small impact immediately after the introduction of the tariff while fertility norms adapt to the new regime.

Similarly, we consider two specifications for education which take the form

$$E_{it} = \beta_0 + \beta_1 M_t * Exp_t + \beta_2 S_i * M_t * Exp_t + \mu_i + \gamma_t + \delta_{3i} t + \delta_{4i} t^2 + \upsilon_{it}, \tag{18}$$

$$E_{it} = \beta_0 + \beta_1 S_i * M_t + \sum_{k>1} \beta_k S_i * M_t + \mu_i + \gamma_t + \delta_{3i} t + \delta_{4i} t^2 + \upsilon_{it}. \tag{19}$$

5 The data

Although France has relatively good historical data, the difficulty lies in the unit of observation that we are interested in: the district or *département*, which we term 'department' throughout the paper. These were the regional administrative units at the time, and are still the main administrative units in France with most of them covering the same areas and having the same names as in the late 19th century, although the number has slightly increased.

We use several sources to compile our data on education, birth rates and fertility. The first is the *Annuaire Statistique de la France*, which provides regional data on live births, total population, the number of students enrolled in primary education, as well as the number of school. To create measures of fertility, enrollment and attendance, we use the census or *Recensement Général*, which is available for the years 1872, 1876, 1881, 1886, 1891, 1896, 1901, 1906, and 1911, and provides data on various groups of population by age and gender. Information on the production of various crops comes from the *Statistique Agricole annuelle*, as compiled by Toutain (1993).

Crude birth rates by department are defined as the number of live births per 1,000 inhabitants, while the fertility rate is computed as the ratio of live births to the number of women

[14] We introduce $M_t * Exp_t$ not interacted with S_i in this specification since it is not collinear neither with the year fixed effects nor with the time trends which are district specific.

aged between 15 and 49 in 1,000s. Demographers have raised concerns about a number of observations given in the census as in certain years the various measures available are not consistent with each other. Corrections of these data have been proposed to take into account this concern and we use those to calculate the fertility rate, as proposed by Van de Walle (1974) and Bonneuil (1997).

Our measure of educational investment are enrolment rates in primary education, a measure that includes both public and private schools. Data are available for the overall number of students enrolled in primary education and for those aged 6 to 13, the difference between the two being presumably older students.[15] The data are available separately for all students, for boys and for girls, so we compute both overall and gender-specific enrolment rates. It is conceivable that the tariff had different effects across the genders. For example, if the tariff made agriculture a more desirable occupation and if this was largely a male-dominate activity, girls' education could have been affected less than boys'. Alternatively, if the tariff had a positive impact on fertility, this may have kept more girls at home to help with household chores and caring for younger siblings.

To obtain enrolment rates for those in the relevant age group we use the population aged 6 to 13, which is available on census years (1881, 1886, 1891, 1896, 1901, 1906, 1911), hence the last observation includes individuals born in 1900, i.e. 8 years after the tariff was introduced. As discussed above the population data by age group is not always reliable, and in a number of cases the enrolment rate we obtain is well over 100%. Since no correction is available for this age group, we simply remove from our sample the observations that are 101% or higher. As an alternative measure we also compute enrolment of those aged between 6 and 13 years as a share of the total department's population. Given the expansion of education that took place over the period, it is important to control for the supply of schooling. We hence compute the number of primary schools per 1000 children aged 6 to 13 and use it as a control in our enrolment regressions.[16]

We start our sample in 1872 and if possible we compile data up to 1913, yielding a 42-year period with half of the observations pre-dating the Méline tariff and half of them occurring after the policy was in place. We exclude from our sample Alsace and parts of Lorraine due to their annexation by Prussia in 1871, as well as Corsica for which there is no data on agricultural employment, thus reducing our sample to 85 departments. Four observations are missing for

[15] See Grew and Harrigan (1991) for an introduction to the data and Luc (1985) for a discussion on the method used by the French education ministry to survey the enrolled.

[16] This variable proved not to be significant in the birth-rate and fertility regressions and is hence not included.

Meurthe et Moselle between 1872 and 1875, as the department was a merge of the two remaining parts of former departments 54 and 57 that were no longer part of France following the 1870 war. Our sample hence contains at most 3566 observations, all of which are available for birth rates. For fertility and enrolment rates the quinquennial availability of censuses reduces our sample to around 500 observations.

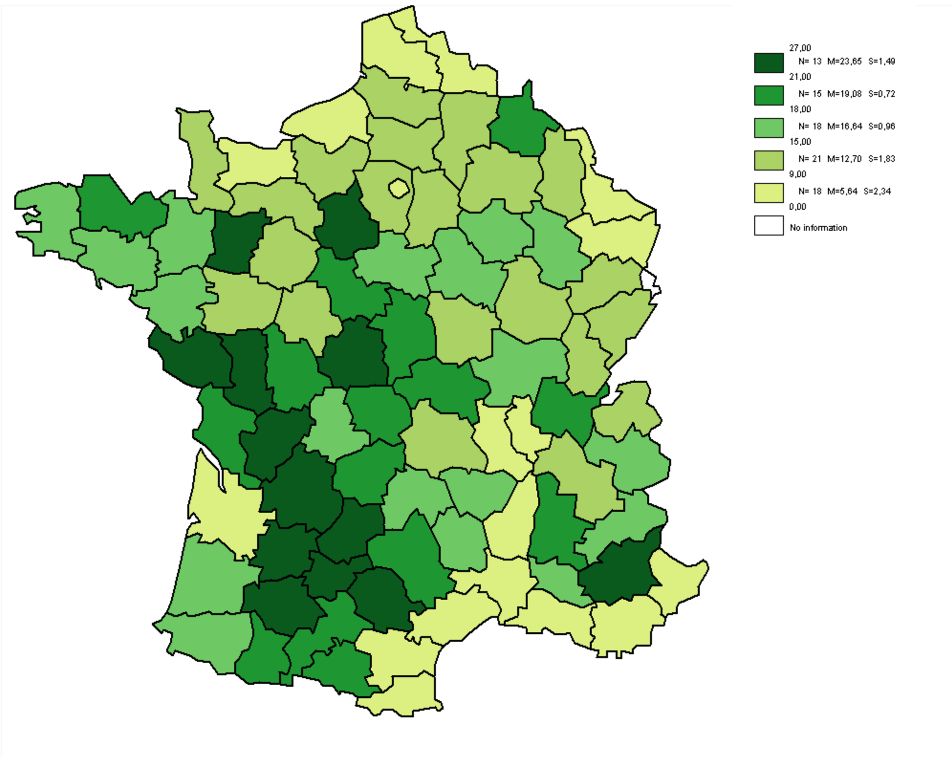
Our policy variable is the interaction between a dummy for the Méline tariff and a measure of the importance of cereal production in the department's economy in 1892. Data on the share of employment in cereal production are not available, hence we use as a proxy the product of the share of agricultural employment in total employment in 1892 and the share of the value of cereal production in total agricultural production in 1892, i.e. the last year before the tariff could have an impact. The data concerning these two variables come, respectively, from Toutain (1993) and Combes, Lafourcade, Thisse, and Toutain (2011). Note that since cereals are generally less labour intensive than other crops, our proxy will be overestimating employment in cereal production. The resulting measurement error will tend to bias our coefficients of interest towards zero, implying that our estimates represent a lower bound of the true effect.[17]

The dummy variable *Méline* takes the value 0 up to 1892 and the value 1 from 1893 onwards, 1893 being the first year in which we could observe a change in birth rates or education. As discussed the time structure of the effect of the policy is of crucial importance, as this variable can have different effects depending on how long the policy has been in operation. We will thus use the variable *Exposure* to measure the number of years that the policy has been in place, and will also allow for differential impacts every three or five years.

Table 2 presents some descriptive statistics. Both birth rates and fertility rates are high although declining throughout the period, with the average in the sample being 94 children per thousand women. The average enrolment rate is 91%, and it varies between 52 and 100%, with the variation being both over time and across departments. Over half of the population was employed in agriculture, the employment share going up to 75% in certain departments. As we can see in the table, cereal production was an important activity in France, accounting for over a quarter of overall agricultural output.

Our variables of interest interact the proxy for the share of employment in cereal production with variables capturing the time structure of the policy: *Méline*Cereal* is the interaction term between this and the dummy taking a value of one from 1893 onwards and zero for earlier years, while *Exposure*Cereal* interact it with a variable that measures the number of years since the

[17] The so-called *attenuation bias*; see Maddala (1977).



Reading of the legend: 13 districts in forest-green are in the 21%-27% bucket of employment share in cereals, with an average of 23.6%

Figure 4: Employment share in the production of cereals in France in 1892

introduction of the tariff. Our proxy for the share of employment in cereal production averages almost 15%, and varied between 26% and 0.07%, with Lot, Tarn et Garonne and Dordogne being the departments with the highest shares and Seine that with the lowest. Note, however, that not all departments with a low employment share in cereals were rich, urban regions. The third lowest share is that of Bouches-du-Rhône, at 3.5%, a relatively poor region with high employment in agriculture but whose climate is not suitable for cereal production. Figure 4 represents the spatial distribution of the share of employment in cereal production. It is important to note that we are not measuring the volume of cereal production, with was highest in the Artois, Beauce and Brie areas, but rather the importance in the local economy of this type of production. As a result, some (although not all) of the Northern departments that produced high volumes of cereal but where agriculture was only a small share of total employment exhibit low values of our variable of interest.

6 Empirical results

6.1 Birth rates and fertility

Table 3 reports the regression results for birth rates. The first column simply includes a 0-1 dummy starting in 1893 which is interacted with the share of employment in cereal production, as well as a department-specific linear time trend. The variable has an insignificant coefficient, indicating that if we impose a common effect over the 20 years following the introduction of the Méline tariff we are unable to identify its effect. As argued by Wolfers (2006), when the underlying process is trended, the way in which the time structure is modelled becomes crucial. The second column hence considers the impact of the number of years during which the policy has been in place (*Exposure*). The coefficient on *Exposure* interacted with the share of cereals is positive and highly significant, indicating that protectionism increased birth rates in those departments with a higher share of cereal employment and that the effect grew over time. Column 3 presents the most flexible specification, based on equation (17), which allows for differential effects every three years. The initial effect, as captured by the coefficient on *Méline*Cereal* is not significantly different from zero, but after three years becomes significant and increases over time, rapidly in the first decade and more slowly afterwards. This seems to imply that households adapted their fertility gradually in response to the change in the relative price of cereals.

The next three columns estimate the same specifications including both a linear and a quadratic department-specific time trend. Coefficients have the same sign and significance, and are somewhat larger. The specification using *Exposure* indicates that the tariff increased the birth rate by 1.33 births in the first year, by 13.3 after 10 years and so on. Similar magnitudes are obtained with the dynamic specification, with no change over the first three years, an increase of about 9.6 births after 10-12 years, and of 19 births after two decades.

Table 4 reports the same specifications using as the dependent variable fertility rates, where, because census data reporting the number of females of child-bearing age is only available every five years, we have only quinquennial observations. The results are consistent with those obtained with birth rates: the interaction between the tariff and cereal production has an insignificant coefficient, but when we allow for a more flexible specification the coefficients are positive and significant. Column 3 reports the regression based on equation (17), with the effect increasing slightly over time.

The magnitude of these effects is large. In a department with 26% of the population employed in cereal production, i.e. the highest share that we observe, 10 years after its introduction the tariff had increased the fertility rate by 5.7 children per 1,000 women (Table 4, column 2). The average increase across all departments is 3.3 children per 1,000 women after 10 years, 6.6 by 1913, figures which are equivalent to 18% and 37% of the standard deviation of fertility. Birth rates increased by 4 children after 20 years, which amounts to 50% of the variation across departments.

As we have discussed, this was a period of declining birth rates and it is interesting to compare the impact of the policy with that of the time trend, since the former offset the decline in births that had been taking place since the late 18th century. Using the formulation in Table 3, column 5, we find that the combination of the time trend and the tariff implies that for the average department, i.e. one with a cereal share of 15%, the birth rate returned to its 1892 level only 17 years after the introduction of the tariff.[18] In other words, the tariff implied a 17-year delay in the reduction of fertility for the average department, while during the same period, departments with no cereal production witnessed a reduction of the birth rate of 3.3 children.

In order to visualize the differential impact of the tariff, figure 5 depicts the evolution of the birth rate in 6 selected departments. Two of them, *Seine* and *Bouches-du-Rhône* have some of the lowest values of our proxy for employment in cereal production, 0.07% and 3.5%. The former encompasses Paris and its surroundings and the latter Marseille and part of Provence, and although they host the two largest cities in France their production structure was very different, with the former having virtually no agricultural employment and the latter having

[18]These calculations use a common time trend estimated on pre-treatment data.

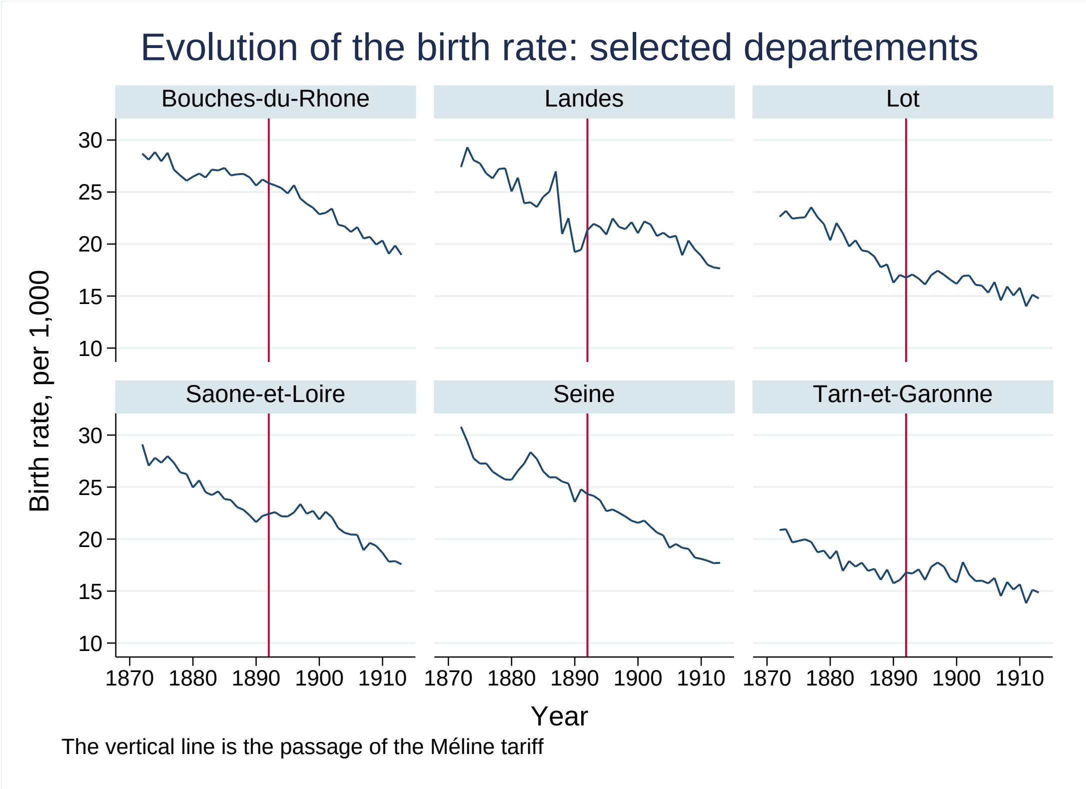


Figure 5: The evolution of the birth rate in 6 selected départements, 1872-1913

almost 20% of the labour force employed in agriculture, the main crops being wine, fruit and vegetables. As we can see, the introduction of the tariff, indicated by the vertical line, did not coincide with any disruption in the time trend for birth rates. *Landes* and *Saône-et-Loire* have average cereal shares, around 15 percent, and in both cases the data indicate an increase in birth rates after 1892. Lastly, *Lot* et *Tarn-et-Garonne* have the largest shares, 26 percent, and in both the rapid decline witnessed over the previous two decades comes to a halt.

6.2 Education

Consider now the effect on education. Table 5 presents the regression results for enrolment rates, defined as the number of students registered in primary education over the relevant age group (6 to 13 year-olds). We report results for all children, for boys only and for girls only since, as we have argued above, the effect could be different across the sexes. The number of observations is constrained by the census years for which we have data on population by age. The last observation is hence for 1911 and includes individuals born between 1898 and 1905, i.e. up to 13 years after the tariff was introduced.

As we argued above, there was a major expansion of the supply of education during the period which we capture by controlling for the number of schools per 1000 children aged 6-13.

As expected this variable has a positive impact on enrolment. The first three columns report our three specifications for all children: one simply including the Méline tariff interacted with cereal employment, one multiplying this share by the number of years of exposure to the tariff, and another that allows for a different effect in years nine and 14 after the tariff's introduction (the first census after the introduction of the tariff is that of 1896). The coefficient on our variable of interest is negative and significant in all specifications. The next columns present two specifications for boys and girls, respectively. The coefficients are significant, have the expected sign, and imply that there is no statistically significant difference between the two gender groups. There are two possible interpretations for this result. If cereal production were not gender-biased in France, the tariff would have the same impact on the relative returns of male and female education. Alternatively, if it were mainly males that worked in the cereal sector, two offsetting effects could be in operation: boys' education fell due to a change in its relative return, while girls were kept out of school in order to help in a household where there were now more younger siblings to care for.

Note that the coefficient on Méline in regression (1), where we impose a common coefficient, is not the average of the three coefficients obtained when we allow for differential effects in column (3). The reason for this is that we include in our specifications a department-specific time trend, and in the absence of differential effects of the tariff over time this trend has to capture the dynamics that are actually due to the policy. These differences indicate the importance of allowing for differential impact of a policy over time, as argued by Wolfers (2006).

The magnitude of the effect is substantial. Table 5, column (1) implies that for a 15% employment rate in cereal production, the tariff reduces enrolment rates by 5.7 percentage points, which amounts to almost 75 percent of the standard deviation of this variable. These effects are large when we compare them to the evolution of enrolment rates over time: over the decade prior to the introduction of the tariff, the enrolment rate increased by only 1.4 percentage points in France. When we allow for different effects across time, we find that the strongest impact occurs nine years after the introduction of the tariff, with the effect falling again by year 14.

Figure 6 depicts six examples of the evolution of enrolment rates: those with the lowest shares of employment in cereal production, *Seine* and *Bouches-du-Rhône*, two with average shares, *Landes* and *Saône-et-Loire*, and those with the highest shares, *Lot* and *Tarn-et-Garonne*. Although enrolment rates appear to have fallen in all departments around 1892, the decline is less marked in the departments including Paris and Marseille, and is particularly strong in *Lot*

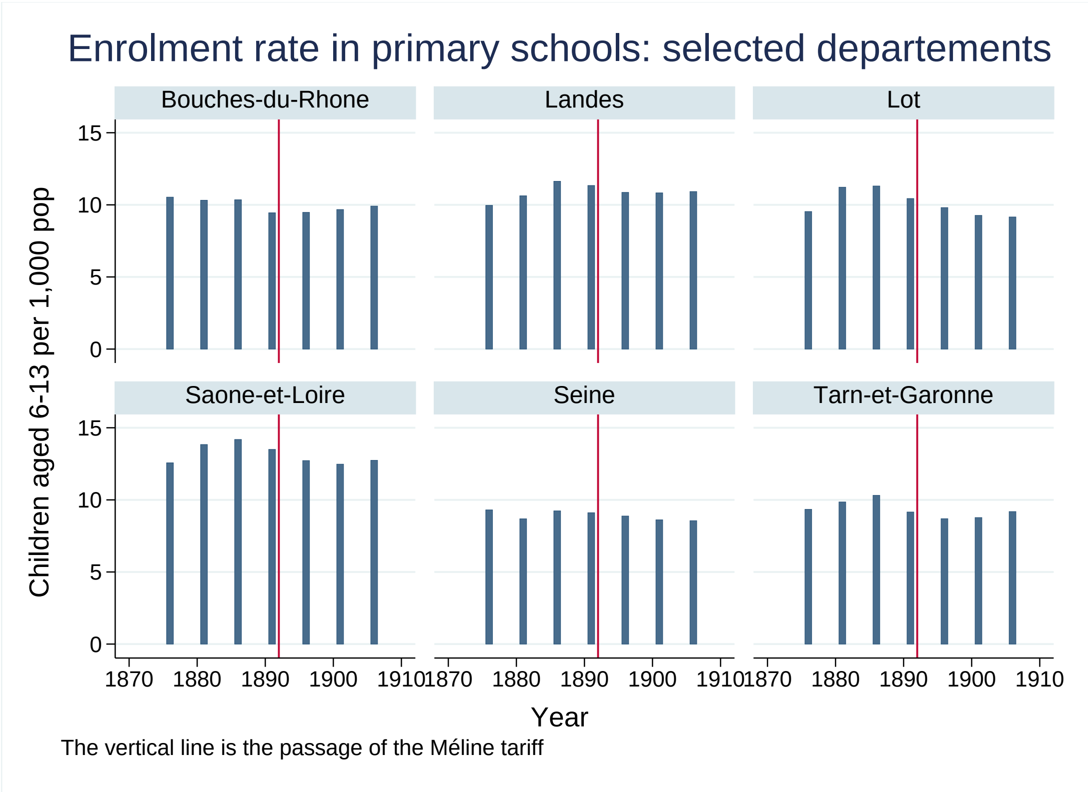


Figure 6: Evolution of the Enrolment Rate in 6 selected départements, France 1876-1906

and *Tarn-et-Garonne*.

6.3 Robustness

To test the robustness of our results we perform several exercises. The first consists of using two alternative agricultural crops. It is possible that our explanatory variable captures some change, for example, technological, that affected another crop. If there is a correlation between employment in the two crops, our explanatory variable could simply be picking the impact of changes related to the other crop. Including the latter would then render the former insignificant. We hence use our *Experience* and *Méline* dummies interacted with the share of employment in wine production and that in fruit and vegetables, both of them major crops in France at the time, with these shares proxied by the product between agricultural employment and the ratio between the total value of the crop's output to the total value of agricultural output in 1892. These two crops differ substantially in that wine, as cereals, is easy to export and import, while the perishable nature of fruit and vegetables implies that these good were less subject to international competition.

The results are reported in table 6. For our three dependent variables -birth rates, fertility rates and enrolment- we obtain equivalent results. The coefficient on the shock interacted with the share of cereal employment remains highly significant and of similar magnitude to those previously obtained. While employment in fruit and vegetable production never exhibits a significant coefficient, that on employment in wine production is significant in two specifications, birth rates and fertility rates. A possible explanation is that the end of the free trade period was perceived as being favorable to all agricultural exports, and thus regions where wine production was important also experienced a stronger increase in birth rates than elsewhere.

Our second specification considers the impact of migration. Migration could be important if the tariff induced migration into the now-richer departments with high employment in cereal production. If national or international migrants to these regions had higher fertility norms, then higher birth rates could be due to migration. We hence collected data on both the share of the population born in France but outside the department and on those born abroad (see appendix for the details). Moreover, we have information on the nationality of foreigners as well as on birth rates in the country of origin in each year. We use this information to construct a measure of 'fertility norms'. We proxy the fertility norm of migrants by the birth in their country of origin at year t relative to that in France in the same year, and compute the average norm for all nationalities present in the department, weighted by the share of immigrants of each nationality. This allows us to control for whether foreigners with higher fertility norms were the reason behind the observed increase in birth rates.

Table 7 reports two sets of regressions: those including weighted fertility, the share of foreign migrants in the population and their interaction, and those including the share of those born outside the department. Our variables of interest retain their significance in all specifications. We find no impact of the additional variables on birth rates, while a higher share of domestic migrants increases fertility, a result consistent with rural workers with high fertility migrating to more industrial regions were fertility had fallen faster. Enrolment rates are negatively affected by the share of foreign migrants, in line with the fact that France had extensive education policies earlier than most of its neighbours, and positively by national migrants. The latter effect is surprising as we would expect domestic migrants from rural areas to be less likely to educate their children, yet could be explained by positive selection of migrants that are both more motivated to move in response to economic conditions and more motivated to educate their children than the average individual. This can also explain why the share of domestic migrants has no effect on birth rates as positive selection offsets the higher fertility norms in the department of origin.

Lastly, we consider two further variables that may have affected the way in which birth rates reacted to the tariff. The first is religious conservatism. The change of government in 1891 implied a more conservative parliament, and it is conceivable that the change in political climate affected attitudes to family size and towards the use of contraception. If so, our dummy could be capturing a strengthening of conservative attitudes which we would expect to be stronger in those department that were originally more conservative. Second, the size of agricultural properties may also have been important. If agricultural production were concentrated in a few large states and hired farm labour were paid close to subsistence wages by landowners, it is conceivable that farmers did not see a direct impact of the tariff on agricultural wages. We hence construct dummies for these two variables at a particular point in time and interact them with the Méline shock.

As a measure of religious conservatism we use the share of priests in a department that did not take the revolutionary oath in 1791. Following the Revolution a "Civil constitution for priests" was promulgated in 1790 that established priests as public employees and made them accountable to the French state rather than to the Vatican. The government requested priests to swear the civil constitution but some of them, the 'clergé réfractaire', refused to do so. These priests became important figures of conservative Catholicism; see Tackett (1977). We hence measure the strength of religious conservatism in a department by the fraction of priests in the department that refused the oath. The structure of property is measured by a dummy variable equal to one if the predominant form of agricultural properties in the department were large properties (larger than 40 hectares; see appendix for the details).

The regressions reported in table 8 indicate that our variable of interest remains significant and maintains the same sign as in our core specifications. The impact of the tariff does not depend on the structure of agricultural properties in any of the specifications, while the degree of religious conservatism has a significant coefficient only in the regression for birth rates. The positive coefficient implies that in more conservative departments there was an increase in birth rates after 1892, possibly the result of a more conservative political mood.

6.4 The timing of the shock

Our next specification considers alternative time shocks in order to examine whether another shock that took place sooner or latter is being proxied by our explanatory variable. We thus construct the *Méline* dummy and the *Exposure* variable as before, except that we either lag them by 10 years (i.e. the shock occurs in 1882) or forward them by 10 years (shock in 1902). We then interact them with the share of cereals in 1882. Table 9 presents the results for the birth rate, the fertility rate and enrolment rates. These specifications are extremely demanding on the data as they include department and year fixed-effects, department-specific time trends, and two shocks with a 10-year interval. The first two columns, reporting results for the birth rate, indicate that although the alternative shocks reduce the significance of our explanatory variable, its coefficient remains significant at the 10% level. For fertility and education we have a much smaller sample size. All the shocks have an insignificant coefficient in the fertility regressions, which as we had seen earlier give the least satisfactory results; in contrast, the two regressions for enrolment rates yield highly significant coefficients for our explanatory variable.

6.5 Child labour

Child labour was prevalent in 19th century France, both in agriculture and in the manufacturing sector; see Heywood (2002). Consequently, the tariff could reduce education because parents faced a trade-off between higher consumption if their offspring worked when they were children and the future skill level of these offspring. An increase in the return to agricultural labour could then induce farmers to make their children work more and hence reduce enrolment rates. Alternatively, given the seasonality of farm work, parents could enroll children at school and have them not attending during the months of intensive farm work, notably the summer.[19] Schooling could then fall, not because fewer children were enrolled but rather because fewer of those enrolled actually attended school.

In order to test this hypothesis, we have collected data on absenteeism reported in the *Statistique Générale de la France*. In the late 19th century, all French schools were visited by an inspector twice during the year. The visits were unannounced and usually took place in December and in June. Unfortunately, the data are not consistently recorded and we have not been able to construct a time series that would allow us to run the specifications previously used. We have nevertheless two observations, for 1896 and 1906, both after the introduction of the Méline tariff. The data give the number of students that were present in the classroom on a particular date in December and in June. We can then compute the rate of presence, defined as the ratio of the number of pupils present to the number of pupils registered.

We examine whether in 1896 and 1906 summer absenteeism was greater in departments where the share of cereal employment was larger. There are several aspects that may affect absenteeism: the level of education of parents, the health status of the population, distance to schools, etc. In order to control for these, we regress the presence rate in summer in a department on the rate of presence at schools in December, as well as on our measure of the importance of cereal production. Absenteeism was large. Average presence was 90% in winter and 87% in

[19] At the time, the summer holidays for primary school pupils lasted one month, usually August.

summer, and the differences across departments were substantial, with certain areas exhibiting summer presence rates of only about two thirds and a seasonal gap of up to 24 percentage points.

The results are reported in table 10. We report both OLS regressions that pool the two years together as well as a random effects model (fixed effects cannot be used since our explanatory variable does not vary over time). The results indicate that at the end of the 19th century, departments with a larger employment share in cereals tended to experience lower school presence, that is, greater summer absenteeism, relative to that observed in winter. As an alternatively, we use the share of employment in agriculture as an explanatory variable, since lower school presence rates could be due to higher shares of agriculture rather than to cereal production. The share of employment in agriculture also has a negative effect although the coefficients are less significant than for cereals, indicating that cereal employment explains better the gap between winter and summer absenteeism than agricultural employment. Although the data is limited, these results indicate that in the post-1892 period the importance of cereal in the local economy was a factor affecting school attendance rates and hence was likely to have had an impact on human capital accumulation.

7 Conclusions

This paper examines how an economic shock affects education and fertility decisions in order to test the validity of the hypothesis that is a cornerstone of Unified Growth Theory. Our identification strategy relies on a major policy shock that took place in late 19th century France, the 1892 Méline tariff, a large tariff on cereal imports that substantially increased the return to agricultural employment. We develop a two-sector model with endogenous education and birth rates in which, under the assumption that the returns to human capital are higher in manufacturing than in agriculture, a change in the price of agricultural goods implies a reduction in the relative return to education and hence leads to both lower investments in human capital and higher fertility rates.

In order to test these predictions, we use data on French departments for the period 1872 to 1913 and compute each department's employment in cereal production just before the introduction of the tariff. Our identification strategy is based on the fact that the Méline tariff had a differential effect across departments depending on the share of cereal production in employment. Three outcome measures are used: birth rates, fertility rates, and enrolment in primary education. We find that, in line with the model, fertility and birth rates increased in departments where cereal production was important, while educational attainment fell.

These results contribute to the debate on the origins of modern growth. Critics of Unified Growth Theory claim that at the time of the fertility transition the number of children was not responsive to economic conditions, but rather the result of social norms and the absence of effective birth-control technologies, while education was largely constrained by its supply. A number of previous analyses using historical data have shown that education affected fertility decisions and vice versa, yet no work has so far examined quantity-quality responses to economic incentives. The main contribution of our paper hence lies in identifying how a major aggregate economic shock can impact households' education and fertility decisions.

Our paper also contributes to a vast literature in economic history on the effects of protectionism, which has largely focused on the wave of anti-free-trade policies that swept Europe in the wake of rising imports from the Americas. The Méline tariff stands out as one of the rare instances of a protectionist policy that had a positive effect, notably resulting in higher real wages. Our results imply a more nuanced evaluation of the tariff, making it responsible for the brief increase in fertility that occurred at the end of the 19th century, as well as for the so-called 'lost decade' in education. Further work is needed to fully understand the consequences of the tariff. In particular, given that fertility and education decisions can be to a large extent perpetuated, protectionism may have created productivity differences across departments that resulted in long term regional disparities. We leave this analysis for future work.

8 Tables

	(1) Obs.	mean	sd	min	max
Cereal share in agricultural production	85	.268	.0775	.0355	.444
Share of employment in agriculture	85	.538	.147	.015	.753
Share of employment in cereals	85	.148	.0612	.0007	.261
Meline*Cereal	85	.0637	.084	0	.261
Exposure*Cereal	3,566	.574	.867	0	3.659
Birth rate	3,566	22.463	3.94	13.803	35.428
Fertility rate	763	93.973	17.19	54.886	175.015
Enrolment rate, 6–13	469	91.570	7.336	51.998	100.562
Enrolment rate, boys	469	92.615	6.633	57.130	100.867
Enrolment rate, girls	469	90.608	8.554	46.867	100.929
No. of schools	469	19.385	6.917	5.222	43.306

Table 2: Descriptive statistics

	(1) Meline	(2) Exposure	(3) Dynamic	(4) Meline	(5) Exposure	(6) Dynamic
Meline*Cereal	-0.0487		1.394	-0.101		1.751
	(1.855)		(1.716)	(1.875)		(1.232)
Exposure		-0.0508			-2.238	
		(0.0359)			(6.812)	
Exposure*Cereal		0.971***			1.334**	
		(0.213)			(0.545)	
Years 4-6*Cereal			3.373***			3.700***
			(1.087)			(1.403)
Years 7-9*Cereal			4.475**			5.214**
			(1.813)			(2.492)
Years 10-12*Cereal			8.354***			9.590**
			(2.334)			(3.885)
Years 13-15*Cereal			11.56***			13.38**
			(2.960)			(5.590)
Years 16-18*Cereal			17.21***			19.69**
			(3.446)			(7.720)
Years 19-21*Cereal			15.85***			19.08**
			(3.881)			(8.969)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.904	0.909	0.910	0.922	0.922	0.923
Observations	3566	3566	3566	3566	3566	3566

Standard errors in parentheses

Standard errors are clustered at the department level. The period of estimation is 1872-1913.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Birth rate

	(1) Meline	(2) Exposure	(3) Dynamic
Meline*Cereal	17.29		21.07*
	(13.78)		(11.40)
Exposure		-0.110	
		(0.172)	
Exposure*Cereal		2.196**	
		(1.062)	
Year 9*Cereal			2.133
			(15.76)
Year 14*Cereal			17.31
			(27.85)
Year 19*Cereal			27.77**
			(12.41)
Linear trend *dpt	Yes	Yes	Yes
Adjusted R^2	0.718	0.719	0.718
Observations	763	763	763

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Fertility rate - census years only

	(1) All children	(2) All children	(3) All children	(4) Boys	(5) Boys	(6) Girls	(7) Girls
No. of schools	1.412**	1.425**	1.332**	1.816***	1.753***	1.802***	1.721***
	(0.644)	(0.653)	(0.657)	(0.428)	(0.440)	(0.389)	(0.398)
Meline*Cereal	-38.20***		-32.52***	-38.42***	-34.08***	-42.75***	-37.02***
	(10.79)		(11.63)	(10.72)	(11.32)	(10.75)	(11.21)
Exposure		0.142					
		(0.266)					
Exposure*Cereal		-3.114**					
		(1.483)					
Year 9*Cereal			-28.60***		-26.71**		-30.66***
			(10.84)		(11.61)		(10.71)
Year 14*Cereal			-11.14		-18.17		-14.90
			(17.61)		(17.03)		(17.52)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.594	0.586	0.602	0.502	0.509	0.678	0.686
Observations	469	469	469	469	469	469	469

Standard errors in parentheses

(1) Enrolment and the schooling population are available for years 1881, 1886, 1891, 1896, 1901, 1906;

(4) Standard errors are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Enrolment rate enrolled over relevant age group

	(1) Birth rate	(2) Birth rate	(3) Fertility	(4) Fertility	(5) Enrolment	(6) Enrolment
Exposure	-2.177	-2.474	-0.355*	-0.0687		
	(6.903)	(6.987)	(0.190)	(0.184)		
Exposure*Cereal	1.589***	1.234**	3.022***	2.357**		
	(0.523)	(0.568)	(1.019)	(1.116)		
Exposure*Wine	0.741*		2.371**			
	(0.440)		(0.978)			
Exposure*FruitVeg		0.937		-1.527		
		(1.476)		(2.743)		
No. of schools					1.419**	1.395**
					(0.654)	(0.639)
Meline*Cereal					-40.12***	-34.90***
					(12.60)	(12.88)
Meline*Wine					-5.508	
					(9.126)	
Meline*FruitVeg						-34.36
						(39.38)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	Yes	Yes	No	No	No	No
Adjusted R^2	0.922	0.922	0.722	0.719	0.593	0.594
Observations	3566	3566	763	763	469	469

Standard errors in parentheses

(1) Enrolment is the enrolment rate of children aged 6-13 over population aged 6-13;

(2) Shock is lagged/brought forward by 10 years;

(3) Residuals are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Robustness: Different crops

	(1) Birth rate	(2) Birth rate	(3) Fertility	(4) Fertility	(5) Enrolment	(6) Enrolment
Exposure	-0.0404	-0.0619	-0.149	-0.122		
	(0.139)	(0.132)	(0.183)	(0.168)		
Exposure*Cereal	1.563*	1.713**	2.442**	2.200**		
	(0.795)	(0.762)	(1.113)	(1.043)		
Weighted fertility	-0.226		1.245		-3.635	
	(1.721)		(12.89)		(11.54)	
Share of migrants	-43.89		-195.5		-423.7**	
	(40.71)		(187.6)		(207.3)	
WeiFert*ShareMig	38.26		129.4		192.7	
	(26.01)		(146.0)		(154.4)	
Born outside dept		1.645		35.79*		33.15*
		(3.391)		(18.93)		(16.93)
No. of schools					1.390**	1.416**
					(0.640)	(0.631)
Meline*Cereal					-34.17***	-38.40***
					(11.03)	(10.92)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	Yes	Yes	No	No	No	No
Adjusted R^2	0.944	0.944	0.719	0.721	0.607	0.598
Observations	763	763	763	763	469	469

Standard errors in parentheses

(1) Enrolment is the enrolment rate of children aged 6-13 over population aged 6-13;

(2) Residuals are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Robustness: National and foreign migrants

	(1) Birth rate	(2) Birth rate	(3) Fertility	(4) Fertility	(5) Enrolment	(6) Enrolment
Exposure	-0.0657	-0.103	-0.151	-0.188		
	(0.125)	(0.128)	(0.234)	(0.251)		
Exposure*Cereal	1.745***	1.727***	2.280*	2.266*		
	(0.542)	(0.553)	(1.152)	(1.157)		
Exp*Conserv	0.319**	0.338**	-0.0316	-0.0141		
	(0.135)	(0.136)	(0.354)	(0.364)		
Exp*LargeProp		0.0673		0.0662		
		(0.0626)		(0.150)		
No. of schools					1.394**	1.409**
					(0.650)	(0.644)
Meline*Cereal					-40.24***	-39.74***
					(11.75)	(11.58)
Mel*Conserv					-1.996	-2.476
					(2.740)	(2.868)
Mel*LargeProp						-1.370
						(1.539)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.936	0.936	0.713	0.712	0.598	0.598
Observations	3314	3314	709	709	442	442

Standard errors in parentheses

(1) Enrolment is the enrolment rate of children aged 6-13 over population aged 6-13;

(2) Residuals are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Robustness: Religious conservatism and size of properties

	(1) Birth rate	(2) Birth rate	(3) Fertility	(4) Fertility	(5) Enrolment	(6) Enrolment
Exposure	0.104	-1.076	0.220	1.517***		
	(0.0847)	(3.784)	(0.264)	(0.417)		
Exposure*Cereal	1.294**	1.535**	2.127	2.445		
	(0.527)	(0.674)	(1.651)	(2.561)		
Exposure lagged	0.0983		-0.595			
	(0.0905)		(0.440)			
Exp*Cereal lagged	-0.138		0.118			
	(0.552)		(2.795)			
Exposure forward		-0.997		-3.444***		
		(2.646)		(0.640)		
Exp*Cereal forward		0.399		-0.466		
		(0.560)		(3.914)		
No. of schools					1.408**	1.401**
					(0.646)	(0.648)
Meline*Cereal					-34.25***	-37.35***
					(12.80)	(11.11)
Mel*Cereal lagged					9.198	
					(14.29)	
Mel*Cereal forward						6.757
						(13.75)
Linear trend *dpt	Yes	Yes	Yes	Yes	Yes	Yes
Quadratic trend *dpt	Yes	Yes	No	No	No	No
Adjusted R^2	0.922	0.922	0.719	0.719	0.594	0.593
Observations	3566	3566	763	763	469	469

Standard errors in parentheses

(1) Enrolment is the enrolment rate of children aged 6-13 over population aged 6-13;

(2) The shock is lagged/brought forward by 10 years;

(3) Residuals are clustered at the departement level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robustness: Different timing

	(1) OLS	(2) OLS	(3) Random effects	(4) Random effects
Presence in December	0.852***	0.841***	0.732***	0.723***
	(0.102)	(0.102)	(0.165)	(0.167)
Cereal	-0.0703*		-0.0664**	
	(0.0408)		(0.0332)	
Agricultural share		-0.0246		-0.0242*
		(0.0169)		(0.0142)
Adjusted R^2	0.289	0.285		
Observations	170	170	170	170

Standard errors in parentheses

(1) Observations are for 1896 and 1906;

(2) Year fixed effects included, clustered s.e. in the random effects model.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Absenteeism: Presence at school in summer

9 Appendix

9.1 Appendix 1

This appendix derives some of the results reported in section 3.

The maximization problem in (5) yields the following first-order conditions with respect to n and e

$$(1-\gamma)n_t(\tau^q + \tau^e e_t) = \gamma\left(1 - (\tau^q + \tau^e e_t)n_t\right), \tag{A.1}$$

$$(1-\gamma)n_t Ey(e_t)\tau^e = \gamma\left(1 - (\tau^q + \tau^e e_t)n_t\right)(1 - q_{t+1})w_{mt+1}h^{'}(e_t). \tag{A.2}$$

Dividing one by the other and using the expression for $h(e)$ we get (7) in the text. Rearranging (A.1) we have

$$(\tau^q + \tau^e e_t)n_t = \gamma. \tag{A.3}$$

Consider now the allocation of labour across sectors. Labour market equilibrium implies $w_{at}p_t = w_{mt}h(e_t)$. Since wages are equal to the marginal product of labour and assuming that $\alpha = 0.5$, we have $ap_t^2 L_{mt} = L_{at}h(e_t)$. Substituting for $L_t = L_{mt} + L_{at}$ and defining $q_t \equiv L_{at}/L_t$, we get equation (8).

Now consider (6) and (7). The equilibrium level of education is defined by the equality $f(e_t, p_t^w, \eta_t; a) = 0$, where the function $f(.)$ is defined as

$$f(e_t, p_t^w, \eta_t; a) \equiv \frac{1-\theta}{\theta}e_t + \frac{a}{\beta\theta}\left(p_t^w(1+\eta_t)\right)^2 {e_t}^{1-\theta} - \frac{\tau^q}{\tau^e}.$$

This function is strictly increasing and concave in e_t , while for $e_t = 0$ we have $f(.) < 0$ and $f(.) = \infty$ for $e_t = \infty$. The function thus takes a negative value at zero and crosses the horizontal axis, implying that there exists a unique positive value of e_t for which $f(.) = 0$. Note also that $f_{p^w} > 0$, $f_\eta > 0$, and $f_a > 0$. Then $de_t/dp_t^w = -f_{p^w}/f_e < 0$, implying that a lower price increases education, while $d(-f_{p^w}/f_e)/da < 0$, indicating that this effect is stronger when a is larger.

Consider now the effect of an increase in the tariff, η. We have that $de_t/d\eta_t = -f_\eta/f_e < 0$, implying that for any given price p_t^w, education will be lower that it would have been without the increase in the tariff. Moreover, since $d(-f_\eta/f_e)/da < 0$, a higher ratio a implies a larger difference between the level of education with the low and with the high tariff.

9.2 Appendix 2

This appendix gives further details on the data.

Territory and population. The French territory was subdivided into 86 *départements*, that were roughly the size of a US county. We dropped the department 'Corsica' because of data availability.

Demographic variables. We use the data available online on the website of the French national statistical institute INSEE (www.insee.fr) and on the website of the *Centre de Recherche Historique* (CRH thereafter) of the EHESS (http://acrh.revues.org/2890). Those data were digitized as part of the ICPSR project (https://www.icpsr.umich.edu/). The number of births, of females aged 15 to 50, of children aged 6 to 13, and of the total of the population is available every 5 years, more precisely in 1872, 1876, 1881, 1886, 1891, 1896, 1901, 1906, 1911. To construct an annual time series for birth rates, the population figures were interpolated yearly using the average of the growth rate of the total population between 2 censuses, except in 1912 and 1913 for which we extrapolate the average growth rate of the 1906-1911 period. We did not interpolate the female and child population.

Primary school enrolment Throughout the period, primary schooling was compulsory between the ages of 6 and 13 but it was common for older children to attend a primary school. A non negligible number of students attended private and confessional schools and we add the number of pupils in those schools to those in public schools. The number of high school students was usually very low in most *départements*, which prevents us from using the enrollment rate in high school as a measure of secondary education. We take three variables in the periodical published by the Ministry of Education 'Statistiques de l'Enseignement Primaire' (statistic on primary education): the number of children (boys and girls) aged 6 to 13 enrolled in primary school (public or private), the total number of students in any of the primary schools, and the total of children aged 6 to 13 in each census. Digitized data are available online at these web addresses http://acrh.revues.org/3376 for the part digitized by the National statistical office INSEE and http://acrh.revues.org/3038 for the part digitized by the CRH of the EHESS. Table 11 gives the name of the file and the name of the three variables used to compute enrollment rate. The following corrections were made to correct for typos and errors. In 1881, the relevant variables in file T53.xls that write the number of children enrolled are V176, V177 and V178. They are obviously miscalculated, and we therefore went back to the data published in the Statistical yearbook of the French government that published in its 1884 edition the number of pupils enrolled in 1881 (Annuaire statistique de la France, 1884, p. 261). In 1896, there is a typo in the online resource for the number of children aged 6 to 13 enrolled in schools for department #41 that we correct using the Annuaire statistique de la France from 22,409 to 32,409. The publication of the survey by the ministry of education was discontinued after 1906. We were able to retrieve the total number of enrolled and the number of children aged 6 to 13 in other sources. We retrieve the number of enrolled students from the section publishing the number on "primary education" in the yearly *Annuaire statistique de la France* (1912, p. 89, reduced to ASF in table 11). We retrieve the number of children aged 6 to 13 by adding the number of children born each year between 1899 to 1905 and alive in 1911. To add 1911 to the database, we add the relevant numbers as they were stored in the census file of 1911 published in dataset number DS244_1 available on the CRH website.

Year	File	Boys & girls Aged 6-13 census	Enrolled Aged 6-13	Enrolled all ages	Girls Aged 6-13 census	Enrolled Aged 6-13	Enrolled all ages	Boys Aged 6-13 census	Enrolled Aged 6-13	Enrolled all ages
1876	print	Table 1	Table 31	Table 28	Table 1	Table 30	Table 28	Table 1	Table 29	Table 28
1881	ENSP T53	V207	V211	ASF	V199	V203	ASF	V191	V195	ASF
1886	ENSP T57	V227	V231	V198	V219	V223	V197	V211	V215	V196
1891	ENSP T79	V142	V146	V111	V133	V137	V110	V124	V128	V109
1896	ENSP T83	V44	V48	V9	V35	V39	V8	V26	V30	V7
1901	DS208_1	V110	V114	V75	V101	V105	V74	V92	V95	V73
1906	DS203	V139	V143	V104	V130	V134	V103	V121	V125	V102
1911	DS244_1	census	NA	ASF	census	NA	ASF	census	NA	ASF

V stands for variable, ASF stands for Annuaire statistique de la France, see text for details

Table 11: Sources used to construct enrollment rates

Additional variables Number of schools: The number of schools is obtained from the *Annuaire Statistique de la France*, which reports both the number of public and of private schools. Starting with the volume for 1879 which reports schools for the academic year 1876-77 we collect data for all census years. No data is available for 1891-92 and hence we use the figures for 1892-3.

Migrants: The census reports data on those living in a department who have not been born in the department. We can hence construct quinquennial series for the fraction of the population who is French but born in another department as well as that of foreigners. Moreover, foreigners are classified according to their nationality, as a result we can construct a weighted proxy for their fertility norms. To do so we use data from Mitchell (2003) on birth rates by country. At each point in time, we construct a measure of the birth rate in the country of origin relative to that of France and compute an average relative birth rate for foreigners, weighted by the size of each nationality among the department's foreign population.

Absenteeism: The data are from *Statistique Générale de la France.* We use figures for primary school students attending school in December and in June, adding up the figures for private and for public schools. These are divided by the total number of students registered at primary schools (private and public).

Religious conservatism: The data are from Tackett (1986) and we are grateful to Mara Squicciarini for providing them to us. We use data on the total number of priests in the department in 1791 and the number of priests that did not take the revolutionary oath to construct the share of conservative priests.

Large properties: The data are from Laurent (1976). He divides departments into three categories according to whether the prevalent form of agricultural property are small, medium sized or large properties, the latter being defined as being those above 40 hectares. We create a dummy that takes the value 1 if large properties dominate.

References

Accominotti, O. and M. Flandreau (2008). Bilateral treaties and the Most-Favored-Nation clause. the myth of trade liberalization in the 19th century. *World Politics 60*, 147–188.

Augé-Laribé, M. (1950). *La politique agricole de la France de 1880 à 1940*. Paris: Presses universitaires de France.

Bairoch, P. (1965). Niveaux de développement économique de 1810 à 1910. *Annales*, 1091–1117.

Bairoch, P. (1972). Free trade and European economic development in the 19th century. *European Economic Review 3*, 211–245.

Bairoch, P. (1989). Les trois révolutions agricoles du monde développé : rendements et productivité de 1800 à 1985. *Annales: Économies, sociétes, Civilisations 44*(2), 317–353.

Bardet, J.-P. and H. Le Bras (1988). *Histoire de la population française*, Volume 3, Chapter La chute de la fécondité, pp. 351–402. Paris: Presses Universitaires de France.

Barral, P. (1968). *Les agrariens français de Méline à Pisani*. Paris: Armand Colin.

Bassino, J. P. and J. P. Dormois (1972). Rainfall, the Méline tariff, and wheat production in mediterranean France. *Australian Economic History Review 50*(1), 23–38.

Becker, G. S. (1960). *Demographic and Economic Change in Developed Countries*, Chapter 'An Economic Analysis of Fertility', pp. 209–249. Princeton (NJ): Princeton University Press.

Becker, G. S. and N. Tomes (1976). Child endowments and the quantity and quality of children. *Journal of Political Economy 84*(4), 143–162.

Becker, S. O., F. Cinnirella, and L. Woessmann (2010). The trade-off between fertility and education: evidence from before the demographic transition. *Journal of Economic Growth 15*, 177–204.

Black, S. E., P. J. Devereux, and K. G. Salvanes (2005). The more the merrier? The effect of family size and birth order on children's education. *Quarterly Journal of Economics 120*(2), 669–700.

Blayo, Y. and L. Henry (1975). La population de la France de 1840 à 1860. *Population 30*(H–S), 71–122.

Bleakley, H. and F. Lange (2009). Chronic disease burden and the interaction of education, fertility, and growth. *Review of Economics and Statistics 91*(1), 52–65.

Bonneuil, N. (1997). *Transformation of the French Demographic Landscape, 1806–1906.* Oxford: Clarendon Press.

Chanut, J.-M., J. Heffer, J. Mairesse, and G. Postel-Vinay (1995). Les disparités de salaires en France au XIXe siècle. *Histoire et mesure 10*(3–4), 381–409.

Chaunu, P. (1972). Malthusianisme démographique et Malthusianisme économique. *Annales: Économies, sociétes, civilisations 26*, 1–19.

Clark, G. and N. Cummins (2015). The child quality-quantity tradeoff, england 1750–1880: Is a fundamental component of economic theory of growth missing? Mimeo.

Combes, P.-P., M. Lafourcade, J.-F. Thisse, and J.-C. Toutain (2011). The rise and fall of spatial inequalities in france; a long-run perspective. *Explorations in Economic History 48*, 243–271.

Cummins, N. (2013). Marital fertility and wealth during the fertility transition : Rural France, 1750–1850. *Economic History Review 66*(2), 449–476.

De La Croix, D. and F. Perrin (2016). French fertility and education transition: Rational choice vs cultural decision. IRES discussion paper 2016-7.

Diebolt, C. (2015). Reflections on causation with special reference to cliometrics. Mimeo.

Diebolt, C., R. Menard, and F. Perrin (2016). Behind the fertility-education nexus: What triggered the French development process? Beta working paper.

Diebolt, C., T. Mishra, and F. Perrin (2015). Did gender-bias matter in the quantity-quality trade-off in 19th century France. Lund Papers in Economic History.

Dormois, J. P. (1996). La vocation agricole de la France. *Histoire et Mesure 11*(3–4), 329–366.

Dormois, J.-P. (2009). *La défense du travail national: L'incidence du protectionnisme sur l'industrie en Europe, 1870–1914.* Paris: Presse Universitaire Paris–Sorbonne.

Dormois, J. P. (2012). With the best intentions? voting patterns in the adoption of the méline tariff, 1891–1892. Mimeo.

Dupaquier, J. (1988). *Histoire de la population française.* Paris: Presses universitaires de France.

Easterlin, R. A. (1976). The conflict between aspirations and resources. *Population and Development Review 2*(3), 417–425.

Federico, G. and K. Persson (2007). *The New Comparative Economic History: Essays in Honor of Jeffrey G. Williamson*, Chapter Market integration and convergence in the world wheat market, 1800-2000, pp. 87114. Cambridge, MA: MIT Press.

Furet, F. c. and M. Ozouf (1977). *Lire et écrire*. Paris: Éditions de Minuit.

Galor, O. and O. Moav (2002). Natural selection and the origin of economic growth. *Quarterly Journal of Economics 117*(4), 1133–1191.

Galor, O. and A. Mountford (2006). Trade and the great divergence: The family connection. *American Economic Review 96*(2), 299–303.

Galor, O. and A. Mountford (2008). Trading population for productivity: Theory and evidence. *Review of Economic Studies 75*(1), 1143–1179.

Galor, O. and D. N. Weil (1999). From malthusian stagnation to modern growth. *American Economic Review 89*(2), 150–154.

Galor, O. and D. N. Weil (2000). Population, technology, and growth: From malthusian stagnation to the demographic transition and beyond. *American Economic Review 90*(4), 806–828.

Golob, E. O. (1944). *The Méline tariff: French agriculture and nationalist economic policy*. New York: Studies in History, economics and public law–AMS press.

Grantham, G. W. (1993). Divisions of labour: Agricultural productivity and occupational specialization in pre-industrial france. *Economic History Review 46*(3), 478–502.

Grew, R. and P. J. Harrigan (1991). *School, State and Society, The Growth of Elementary Schooling Nineteenth-Century France–A Quantitative Analysis*. Ann Arbor: Clarendon Press.

Guinnane, T. W. (2011). The historical fertility transition: A guide for economists. *Journal of Economic Literature 49*(3), 589–614.

Harley, K. (1988). Ocean freight rates and productivity, 1740-1913: the primacy of mechanical invention reaffirmed. *Journal of Economic History 48*(4), 851–876.

Henriksen, I., M. Lampe, and P. Sharp (2011). The role of technology and institutions for growth: Danish creameries in the late nineteenth century. *European Review of Economic History 15*(3), 475–493.

Heywood, C. (2002). *Childhood in nineteenth-century France: work, health and education among the classes populaires*. Cambridge: Cambridge University Press.

Jacks, D. P. (2006). New results on the tariff–growth paradox. *European Review of Economic History 10*, 205–230.

Kindleberger, C. P. (1950). Group behavior and international trade. *Journal of Political Economy 59*(1), 30–46.

Lampe, M. and P. Sharp (2013). Tariffs and income: A time series analysis for 24 countries. *Cliometrica 7*(3), 207–235.

Laurent, R. (1976). *Histoire économique et sociale de la France: L'avénement de l'ère industrielle*, Chapter Les cadres de la production agricole: Propriété et modes d'exploitation, pp. 629–661. Paris: P.U.F.

Levasseur, E. (1911). *Histoire du commerce de la France*. Paris: Librairie nouvelle de droit et de jurisprudence.

Lhomme, J. (1970). La crise agricole la fin du xixe sicle en france. essai d'interprtation conomique et sociale. *Revue Economique 21*(4), 521–553.

Luc, J.-N. (1985). *La Statistique de l'Enseignement Primaire 19e-20e Siècle, Politique et Mode d'Emploi*. Paris: INRP Economica.

Maddala, G. (1977). *Econometrocs*. New York: McGraw Hill.

Mitchell, B. R. (2003). *International Historical Statistics Europe*. Basingstoke, U.K.: Palgrave McMillan.

Murphy, T. (2015). Old habit die hard (sometimes): What can Département heterogeneity tell us about the French fertility decline? *Journal of Economic Growth 20*(2), 177–222.

North, D. C. (1958). Ocean freight rates and economic development, 1750-1913. *Journal of Economic History 18*(4), 537–555.

Nye, J. V. (1991). The myth of free trade Britain and fortress France: Tariffs and trade in the nineteenth century. *Journal of Economic History 51*(1), 23–46.

Nye, J. V. (2007). *War, wine, and taxes: the political economy of Anglo–French trade, 1689–1900*. Princeton: Princeton University Press.

O'Brien, P. and C. Keyder (2011). *Economic growth in Britain and France 1780–1914: two paths to the Twentieth Century*. London: Routledge.

O'Rourke, K. H. (1997). The european grain invasion, 1870–1913. *Journal of Economic History 57*(4), 775–801.

O'Rourke, K. H. (2000). Tariffs and growth in the late 19th century. *Economic Journal 110*, 456–483.

Postel-Vinay, G. (1991). *Entre l'état et le marché. L'économie française des années 1880 à nos jours*, Chapter L'agriculture dans l'économie Française, pp. 59–92. Paris: N.R.F. Gallimard.

Postel-Vinay, G. (1998). *La terre et l'argent. L'agriculture et le crédit en France au début du XXe siecle.* Paris: Albin Michel.

Prost, A. (1993). Pour une histoire "par en bas" de la scolarisation républicaine. *Histoire de l'éducation 57*(1), 59–74.

Rosenzweig, M. R. and K. I. Wolpin (1980). Testing the quantity-quality fertility model: The use of twins as a natural experiment. *Econometrica 48*(1), 227–240.

Rosenzweig, M. R. and J. Zhang (2009). Do population control policies induce more human capital investment? twins, birthweight, and china's 'one child' policy. *Review of Economic Studies 76*(3), 1149–1174.

Schultz, P. T. (1985). Changing world prices, womens wages, and the fertility transition: Sweden, 1860–1910. *Journal of Political Economy 93*(6), 1126–1154.

Sicsic, P. (1992). City-farm wage gaps in late nineteenth-century France. *Journal of Economic History 52*(3), 675–695.

Simiand, F. (1931). *Le salaire, l'évolution sociale et la monnaie*, Volume 3. Paris: Felix Alcan.

Tackett, T. (1977). *Priest and Parish in Eighteenth-Century France.* Princeton: Princeton University Press.

Tackett, T. (1986). *Religion, Revolution, and Regional Culture in Eighteenth-Century France: The Ecclesiastical Oath of 1791.* Princeton: Princeton University Press.

Tena-Junguito, A., M. Lampe, and F. Tâmega Fernandes (2012). How much trade liberalization was there in the world before and after cobden-chevalier? *Journal of Economic History 72*(3), 708–740.

Toutain, J.-C. (1993). La production agricole de la France de 1810 à 1990: Départements et régions. *Economies et Sociétés: Histoire économique quantitative de l'économie Franqise 17*(1-2).

Uebele, M. (2011). National and international market integration in the 19th century: Evidence from comovement. *Explorations in economic history 48*, 226–242.

Van de Walle, E. (1974). *The female population of France in the nineteenth century: A reconstruction of 82 departements*. Princeton: Princeton University Press.

Van de Walle, E. (1980). *Family and Sexuality in French History*, Chapter Motivations and Technology in the Decline of French Fertility. Philadelphia: University of Pennsylvania Press.

Weber, E. (1976). *Peasants into Frenchmen: The Modernisation of Rural France, 1870–1914*. Stanford: University of California Press.

Weir, D. R. (1984). Life under pressure: France and England, 1670–1870. *Journal of Economic History 44*(1), 27–47.

Wolfers, J. (2006). Did unilateral divorce laws raise divorce rates? A reconciliation and new results. *American Economic Review 96*(5), 1802–1820.

Wrigley, A. E. (1985a). The fall of marital fertility in nineteenth century France: Exemplar or exception? (part I). *European Journal of Population 1*(1), 31–60.

Wrigley, A. E. (1985b). The fall of marital fertility in nineteenth century France: Exemplar or exception? (part II). *European Journal of Population 1*(2–3), 141–177.

Zolla, D. (1903). *La crise agricole dans ses rapports avec la baissse des prix et la question monétaire*. Paris: Naud.