Why is infant mortality higher in the US than in Europe?*

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Abstract

The US has a substantial – and poorly understood – infant mortality disadvantage relative to peer countries. We combine comprehensive micro-data on births and infant deaths in the US from 2000 to 2005 with comparable data from Austria and Finland to investigate this disadvantage. Differential reporting of births near the threshold of viability can explain up to 40% of the US infant mortality disadvantage. Worse conditions at birth account for 75% of the remaining gap relative to Finland, but only 30% relative to Austria. Most striking, the US has similar neonatal mortality but a substantial disadvantage in postneonatal mortality. This postneonatal mortality disadvantage is driven almost exclusively by excess inequality in the US: infants born to white, college-educated, married US mothers have similar mortality to advantaged women in Europe. Our results suggest that high mortality in less advantaged groups in the postneonatal period is an important contributor to the US infant mortality disadvantage.

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1 Introduction

In 2013, the US infant mortality rate (IMR) ranked 51st internationally, comparable to Croatia, despite an almost three-fold difference in GDP per capita.[1] One way to quantify the magnitude of this infant mortality disadvantage is to consider that the US IMR is about 3 deaths per 1000 greater than Scandinavia. Aggregating 4 million annual US births and taking a standard value of life estimate of US$7 million (Viscusi and Aldy, 2003) suggests that reducing the US IMR to that of Scandinavian countries would be worth on the order of US$84 billion annually. By this metric, it would be "worth it" to spend up to $21,000 on each live birth to lower the infant mortality risk to the level in Scandinavia.

While the US IMR disadvantage is widely discussed and quantitatively important, the determinants of this disadvantage are not well understood, which hinders policy efforts aiming to reduce the US infant mortality rate. A key constraint on past research has been the lack of comparable micro-datasets across countries. Cross-country comparisons of aggregate infant mortality rates provide very limited insight, for two reasons. First, a well-recognized problem is that countries vary in their reporting of births near the threshold of viability. Such reporting differences may generate misleading comparisons of how infant mortality varies across countries. Second, even within a comparably reported sample, the observation that mortality rates differ one year post-birth provides little guidance on what specific factors are driving the US disadvantage.

In this paper, we relax this data constraint. We combine US natality micro-data with similar data from Finland, which has one of the lowest infant mortality rates in the world, and Austria, which has similar infant mortality to much of continental Europe. We first provide a detailed accounting of the US IMR disadvantage, quantifying the importance of differential reporting, conditions at birth (that is, birth weight and gestational age), neonatal mortality (deaths in the first month), and postneonatal mortality (deaths in months 1 to 12). To the best of our knowledge, cross-country micro-data has not previously been used to undertake this type of exercise. Second, we provide new evidence on the demographic composition of the US IMR disadvantage.

Our accounting exercise yields several important findings. First, consistent with past evidence (MacDorman and Mathews, 2009), differential reporting of births cannot offer a complete explanation for the US IMR disadvantage. However, differential reporting is potentially quite quantitatively important, explaining up to 40% of the US IMR disadvantage. This finding highlights the importance of conducting cross-country comparisons in micro-data where reporting differences can be addressed, which is typically not possible in the types of aggregate statistics compiled by the World Health Organization and the World Development Indicators (World Health Organization, 2006; World Bank, 2013).

Second, differences in health at birth are widely cited as *the* major driver of the US IMR disadvantage (MacDorman and Mathews, 2009; National Research Council, 2013; Wilcox et al., 1995). We explore this claim in our comparably reported sample. Consistent with past evidence that has focused on comparing the US with

[1] Croatia's IMR in 2013 was 5.96, relative to 5.9 in the US; GDP per capita was $18,100 in Croatia and $50,100 in the US (CIA, 2013).

Scandinavian countries, we find that birth weight can explain 75% of the US IMR disadvantage relative to Finland. However, birth weight can only explain 30% of the US IMR disadvantage to Austria. Moreover, simple summary statistics make clear that differences in health at birth do not offer a complete explanation, given that even normal birth weight infants have a substantial IMR disadvantage - 2.3 deaths per 1000 in the US, relative to 1.3 in Finland and 1.5 in Austria.

Third, our data allows us to distinguish between neonatal and postneonatal deaths in our comparably reported sample, and to investigate both raw comparisons and comparisons that condition on detailed measures of health at birth. The neonatal/postneonatal distinction is informative because the relevant causes of deaths in these two time periods are quite different (Rudolph and Borker 1987). Previous comparisons of neonatal and postneonatal mortality in aggregate data (such as Kleinman and Kiely (1990)) are difficult to interpret given the differential reporting concern. To be more concrete on the concern which arises when using aggregate data: in an unrestricted sample the US has much higher neonatal mortality than either Austria or Finland (World Health Organization, 2006), whereas our comparably reported sample suggests differences in reporting could be driving nearly all of that pattern.

In our comparably reported sample, the US neonatal mortality disadvantage is quantitatively small and appears to be fully explained by differences in conditions at birth. In contrast, the US has a substantial disadvantage relative to either Finland or Austria in the postneonatal period even in our comparably reported sample and even conditional on circumstances at birth. A simple illustration can be seen in Figure 3, which shows the cumulative probability of death for all births in the three countries. The infant mortality rate in the US is higher everywhere, but this difference accelerates dramatically after the first month of life.

If we condition on birth weight as a measure of health at birth, the US actually has an *advantage* in the first month of life relative to either Austria or Finland, but retains a disadvantage in the postneonatal period. The estimated gap in postneonatal mortality is large: if the US attained the postneonatal mortality rate of Austria or Finland – *with no change in conditions at birth* – it would close about 70% of the overall infant mortality gap with Austria, and 40% of the gap with Finland. Hence, the US postneonatal mortality disadvantage is comparable in importance to differences in health at birth, a finding that has not previously been documented.

Importantly, this excess postneonatal mortality does not appear to be driven by the US delaying potential neonatal deaths: the postneonatal disadvantage appears strongly even among normal birth weight infants and those with high APGAR scores. In an appendix, we document that a similar importance of the postneonatal period emerges if the US is compared to two other countries – the UK and Belgium – where we are limited to observe more aggregated data in a comparably reported sample that distinguishes age of death. We also analyze data on causes of death, and - with caveats about coding reliability - document that SIDS, sudden deaths, and accidents appear to be most important in accounting for the excess postneonatal mortality.

Our second set of results investigates the socioeconomic profile of the US IMR disadvantage. It is well-known that infant mortality in the US varies strongly across racial and education groups (as documented by,

for example, Case et al. (2002)). Given this, a natural question is whether the US IMR disadvantage relative to Europe is accounted for by higher cross-group IMR inequality in the US relative to Europe, or whether even highly advantaged Americans are in worse health than their counterparts in peer countries (as National Research Council 2013 argues). We document that the US postneonatal disadvantage is driven almost entirely by excess mortality among individuals of lower socioeconomic status. We show that infants born to white, college-educated, married women in the US have mortality rates that are essentially indistinguishable from a similar advantaged demographic in Austria and Finland.

Given that one of the most striking facts about infant mortality in the US is the disparity in mortality between black and white infants, it is important to note that the facts we document in this paper are essentially unchanged if we exclude US blacks from the sample. The literature investigating the black-white IMR gap has generally concluded that differential health at birth can account for the vast majority of the black-white gap, and that differences in postneonatal mortality are both less important and can be accounted for by differences in background characteristics (Miller 2003; Elder, Goddeeris and Haider 2011). In contrast, our findings suggest that differences in postneonatal mortality account for as much or more of the US IMR disadvantage relative to Europe than do differences in health at birth, and that these differences in postneonatal mortality are not eliminated by conditioning on a set of (albeit, limited) background characteristics. Taken together, the prior literature and our analysis suggest that the mechanisms explaining the black-white IMR gap within the US may be different from the mechanisms explaining the US IMR disadvantage relative to Europe.

This paper relates to two earlier literatures, one in medicine and one in economics. In the medical literature, most analyses have focused on differences in health at birth as the key explanation for the US IMR disadvantage (MacDorman and Mathews 2009; National Research Council 2013; Wilcox et al. 1995). As we note above, our data suggest this explanation is incomplete and that excess postneonatal mortality may be equally important. Consistent with that finding, Kleinman and Kiely (1990) document that the US had a disadvantage in aggregate postneonatal mortality in the 1980s. This suggests that the disparities in postneonatal mortality we see are long-standing, although those authors did not have access to international micro-data, which limits their ability to analyze groups with comparable reporting.

In the economics literature, this paper relates closely to the work of Case et al. (2002) who use various US survey datasets to investigate the changing relationship between health status and family income as children age (examining age ranges starting at 0-3 and ending at 13-17). They document that health erodes more quickly with age for children from lower socioeconomic status families; as in our study, this fact is not altered by conditioning on measures of health at birth. Currie and Stabile (2003) document a similar finding in Canadian survey data, as do Case et al. (2008) (revisiting an earlier analysis by Currie et al. (2007)) in UK data.[2] Our analysis suggests that the health gradient in the US largely emerges after the first month of life, which accords

[2]A broader literature has examined the relationship between health and socioeconomic status at older ages, such as Ford et al. (1994) and Power and Matthews (1997).

with Case and coauthors' conclusion that the gradient increases with age in the US. However, our data from Austria and Finland provides stark evidence that no similar gradient emerges during the first year of life in those countries.

In terms of policy implications, these new facts suggest that a sole focus on improving health at birth (for example, through expanding access to prenatal care) will be incomplete, and that policies which target less advantaged groups in the postneonatal period may be a productive avenue for reducing infant mortality in the US. One potential policy lever would be home nurse visiting programs, which have been shown to reduce postneonatal mortality rates in randomized trials (Olds et al. 2007).

2 Data

2.1 Data description

Our analysis relies on micro-data from three countries: the US, Austria, and Finland. The US data comes from the National Center for Health Statistics (NCHS) birth cohort linked birth and infant death files. Austrian data is provided by Statistics Austria, and Finnish data is extracted from the Finland Birth Registry and Statistics Finland. As in prior research that has focused on comparing the mortality outcomes of US infants with infants from Scandinavian countries such as Norway (Wilcox et al. 1995), Finland provides a sense of "frontier" infant mortality rates. We chose Austria as a second point of comparison because of the availability of micro-data. Notably, over the time period of our study (2000-2005), Austria's IMR is similar to much of continental Europe.

The data for each country consists of a complete census of births from years 2000-2005, linked to infant deaths occurring within one year of birth. While birth and death certificates in the US and Finnish data are centrally linked, we link the Austrian records using a unique identifier constructed from the thirty-six variables common to both the birth and death records. Each country's birth records provide information on a rich set of covariates, including the infant's conditions at birth, and some information on demographics of the mother. For infants who die within one year of birth, we observe age and cause of death.[3] We exclude from our analyses observations which are missing data on birth weight or gestational age (1.0% in the US, none in Austria, 0.4% in Finland). For the analysis of variation by socioeconomic status we exclude observations which are missing any of our socioeconomic status covariates (2.2% in US, none in Austria, 10.9% in Finland). The higher share in Finland is primarily due to missing occupation data.

[3]To code cause of death as consistently as possible across years, we use the NCHS General Equivalence Mappings (GEMs) to cross-walk across ICD9 and ICD10 codes. After converting all ICD9 codes to ICD10 codes, we use the NCHS recode of the ICD10 – specified in the NCHS birth cohort linked birth and infant death documentation – to consistently code causes of death across all countries and all years. The GEM files are available here: `ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Publications/ICD10CM/2010/2010_DiagnosisGEMs.zip`. For Austria, causes of death prior to 2002 are ICD9 codes, and from 2002-2005 are ICD10 codes. For Finland, causes of death are ICD10 codes. For the US, the original cause of death variable is the NCHS ICD10 recode. A handful of observations have multiple matches from the ICD9 coding to the NCHS ICD10 recode; for these observations, we randomly select one NCHS recode value from the set of possible matches.

2.2 Summary statistics

Summary statistics are shown in Table 1. As expected, infant mortality is higher among US infants than among infants in Austria or Finland. The first row shows overall mortality. Panel A then follows with mortality, gestation, and birth weight in our restricted sample of singleton births at least 22 weeks of gestation and weighing at least 500 grams (this sample restriction is discussed in more detail in Section 3.1). This sample restriction lowers the death rates in all three countries. In terms of conditions at birth, US and Austrian infants look quite similar: Austrian births are on average 0.18 weeks earlier and 13 grams heavier. In contrast, Finnish newborns look to be better off: relative to the US, Finnish births are an average of 0.60 weeks later, and over 200 grams heavier.

In Panel B we consider the sample for which we observe demographics and provide summary statistics on demographic covariates as well. This further sample restriction does not substantially change death rates, gestational age or birth weight. Mother's age is lowest in the US at 27 years, and closer to 29 years in Austria and Finland. Fifteen percent of births in the US are to black mothers; race is reported only in the US, so the mean of this variable is missing in Austria and Finland (we do not use any information on race or ethnicity for Austria or Finland). The share of births to married women is approximately 60 to 65 percent in all three countries.

We also report the mean of an education/occupation variable which – by construction – has a mean of approximately 25 percent in each country. In the United States data, we define "high education" as the mother having a college degree or more (26% of births). We attempt to generate similar breakdowns in Austria and Finland as follows. In the Austrian data, we define "high education" as the mother having a high school degree with A-levels, or a university degree (27% of births). In the Finnish data, we observe only occupation data: we define "high occupation" as the mother having a high level white collar job or being an entrepreneur (22% of births). Given concerns that a mapping between "high education" and "high occupation" is rough at best, we document our results on cross-group differences separately for Austria (where we have a comparable education measure to that available in the US data) and for Finland (where we do not).

3 Results: Accounting for US IMR Disadvantage

Our accounting exercise investigates four potential sources of the US IMR disadvantage: reporting differences, conditions at birth, neonatal and postneonatal mortality.

3.1 Reporting Differences

A well-known issue with cross-country comparisons of infant mortality is possible differences in reporting of infants born near the threshold of viability. Extremely preterm births recorded in some places may be considered

a miscarriage or still birth in other countries (Golding 2001; Graafmans et al. 2001; Sachs et al. 1995; Wegman 1996). Since survival before 22 weeks or under 500 grams is very rare, categorizing these births as live births will inflate reported infant mortality rates (which are reported as a share of live births).

The past literature (notably MacDorman and Mathews (2009)) has addressed this concern by limiting the sample to infants born after 22 weeks of gestation. Although the previous literature has largely focused on the fact that this restriction does not substantially change the rank of the US IMR relative to other countries, this restriction is nonetheless quite quantitatively important. This can be seen by comparing the first and second bars for each country in Figure 1. The first bar shows the excess deaths in the US relative to other countries in the full sample. The second bar limits to infants born at or after 22 weeks of gestation. The US disadvantage declines.

Our data allows us to address two related issues which prior literature has not explored. First, many countries also have reporting requirements related to birth weight and may not report infants under 500 grams as live births (MacDorman and Mathews 2009). Second, the presence of assisted reproductive technologies has increased the frequency of multiple births, which have higher mortality rates. Because the use of assisted reproductive technologies is a choice that we need not aim to fix via changes in policy or behavior, it seems appropriate to limit the data to singleton births. The third column within each country in Figure 1 adds both of these sample restrictions.

The US disadvantage shrinks further with these additional restrictions. Overall, limiting to a sample of singleton births at birth weights and gestational ages where reporting is not a concern reduces the excess US infant mortality by 43% relative to Finland and 39% relative to Austria. However, even with this restriction the US disadvantage remains sizable: the US infant mortality rate in this comparably reported sample is 4.65 per 1000, versus 2.94 in Austria and 2.64 in Finland. We focus on this sample in the remainder of our analysis.

3.2 Conditions at Birth

In contrast to the dismissal of reporting differences as a complete explanation, past literature has argued that high preterm birth rates in the US are the major contributor to higher infant mortality rates (MacDorman and Mathews, 2009; Wilcox et al., 1995). This literature has generally compared the US to the Scandinavian countries which have among the lowest infant mortality rates in Europe, and has generally focused on gestational age (which is more readily available in aggregate datasets) rather than birth weight. Our data expand this previous literature in two ways – first, by incorporating the comparison with Austria, which is closer to the middle of the European distribution but still much better off than the US; and, second, by adding comparisons based on birth weight, which is typically more precisely measured (Dietz et al. 2007).

Figure 2 shows the distribution of gestational age (Figure 2a) and birth weight (Figure 2b) across the three countries in our sample. The figures tell a similar story; we focus attention on the birth weight data. Consistent

with the sample means reported in Table 1, Finland had a much heavier birth weight distribution than the US. However, the birth weight distribution in Austria is quite similar to that of the US.

Following the previous literature, in Column 1 of Table 2 we calculate counterfactual infant mortality rates for the US given the Finnish or Austrian birth weight distribution and the US infant mortality conditional on birth weight. This calculation illustrates the following thought experiment: if the US changed nothing post-birth but achieved the birth weight distribution in these other countries, how much would the US infant mortality rate change? Achieving the Austrian birth weight distribution would close about 30% of the gap with that country, whereas achieving the Finland birth weight distribution would close approximately 75% of the gap with that country. This evidence confirms existing arguments that conditions at birth matter for the US infant mortality disadvantage, although it suggests that focusing on Scandinavian countries may overstate the importance of this explanation.

Even without this calibration, simple summary statistics make it clear that the conditions-at-birth explanation is incomplete. Among normal birth weight infants in the US the infant mortality rate is 2.3 deaths per 1000 births, versus just 1.3 for Austria and 1.5 for Finland.

3.3 Timing of the US IMR Disadvantage: Neonatal and Postneonatal Mortality

We turn now to examine the timing of the US IMR disadvantage. It is here that the value of having micro-data becomes even clearer. The previous literature has been unable to compare mortality timing within the first year across countries in non-aggregate data, which is crucial in light of the reporting differences highlighted above. In unrestricted 2005 data from the World Development Indicators, US neonatal mortality is 2.3 deaths per 1000, versus 2.7 in Austria and 2.1 in Finland (World Bank, 2013). Postneonatal mortality differs less in this sample: 2.3 in the US, versus 1.3 in Austria and 1.0 in Finland. However, differences in reporting could be an important driver of these trends - particularly for neonatal mortality - and from a policy perspective it is also important to understand whether these differences persist when comparing across infants with the same measured health at birth.

Evidence on the timing of the US IMR disadvantage appears in Figures 3 and 4, which show the cumulative probability of death by age by country. In the full comparably reported sample (Figure 3) the US 1-day IMR (in deaths per 1000 live births) is 0.23 higher than Austria and 0.40 higher than Finland. Within the first week these differences increase only slightly – to 0.31 and 0.48. However, between 1 month and 1 year these differences accelerate: the differences at 1 year are 1.70 and 2.00.

This postneonatal mortality disadvantage is even more striking in Figure 4, which graph the cumulative probability of death over the first year separately for normal (>=2500 grams) and low (<2500 grams) birth weight infants. As expected, within each group mortality rates at 1 year in the US are higher than in Austria and Finland. Figure 4a clearly suggests that the US IMR disadvantage arises in the postneonatal period: the US

has virtually identical mortality rates to Austria and Finland up to 1 month, and then much higher mortality after 1 month. The pattern of mortality differences among low birth weight infants in Figure 4b looks very similar to Figure 4a, the only difference being that the US actually seems to have *lower* mortality than Finland during the first month of life.

Table 2 quantifies the intuition in these figures. This table presents the actual infant mortality rate in the US along with the mortality rate predicted for the US given a specified set of characteristics of either Austria or Finland. As described in Section 3.2, in Column 1 we ask what the US infant mortality rate would be if the US adopted the birth weight distribution of either Finland or Austria but retained US mortality rates conditional on birth weight. In Column 2, we ask how the US mortality rate would change if birth weight remained the same but the US adopted either the Austrian or Finnish mortality rates in the first month of life (conditional on birth weight). Column 3 asks a similar question for mortality from 1 to 12 months.

Panel A of Table 2 uses the entire sample. Column 2 demonstrates that the US has a mortality *advantage* in the first month of life relative to Finland. If the US retained the existing birth weight distribution and postneonatal mortality, but converged to the Finnish mortality rates in the first month of life, total mortality would increase from 4.64 per 1000 to 4.84 per 1000. In contrast, the US has a significant disadvantage in the postneonatal period, as shown in Column 3. Adopting either the Austrian or the Finnish postneonatal mortality would dramatically decrease the US infant mortality rate, even holding constant the birth weight distribution. If the US were able to achieve the same mortality schedule as Austria during this period, infant mortality would decline by more than 1 death per 1000 births, amounting to about 4000 deaths averted per year.

Panels B and C of Table 2 separate the sample into low and normal birth weight infants. These panels demonstrate the importance of the postneonatal period even within a birth weight category. They also underscore the advantage the US has, relative to Finland, in the neonatal period. Comparing across Panels B and C, a convergence in postneonatal mortality would impact both normal and low-birth weight babies; both groups are more vulnerable in the US during the postneonatal period.

The separation into normal and low birth weight infants is of course only a rough measure of conditions at birth. In Table 3 we estimate cross-country differences in marginal (non-cumulative) death rates conditional on detailed measures of birth weight (in 500 grams bins). The goal here is to draw conclusions about differences in mortality that would arise even if the US replicated the full distribution of conditions at birth for newborns in Finland or Austria.

We estimate impacts in three timing bins: <1 week, 1 week to 1 month, and 1-12 months. As we expect based on Table 2, the US has a mortality advantage in the earliest period. Relative to either country, the US has lower mortality through the first week of life. In the postneonatal period (from 1 month to 1 year), the US has a significant disadvantage relative to Finland and, especially, relative to Austria. Fully conditional on birth weight cells, Austria actually has the lowest infant mortality rate of the three countries.[4]

[4]Replacing the 500 gram birth weight bins with 100 gram birth weight bins yields virtually identical results.

This pattern is not driven by very small infants: in Appendix Table C.1 (row 2) we show similar patterns if we exclude births less than 1000 grams. It is also not driven by differences in average demographics across the three countries. In Appendix Table C.1 (row 3) we replicate these regressions controlling for maternal age, child sex and maternal demographics with identical conclusions.

One possible theory is that the observed elevation in postneonatal mortality is driven by a delay of deaths in the US. If hospitals in the US are better at keeping very low birth weight newborns alive for a slightly longer period of time, this could show up in the data as low neonatal mortality and excess postneonatal mortality. It is clear from the fact that we see elevated US infant mortality at one year that this is not a complete explanation. In addition, two pieces of data suggest this type of substitution is unlikely to be quantitatively important. First, this type of substitution would be less important among groups which have low rates of neonatal mortality, such as normal birth weight infants or infants with a high APGAR score. Yet these groups also have much elevated postneonatal mortality, as can be seen in Figure 4 for normal birthweight infants, and row 4 of Appendix Table C.1 for infants with APGAR scores of 9 or 10. Second, as we will see in Section 3.4, the causes of excess postneonatal death, such as accidents, are not those that we would expect to be important if deaths were simply delayed from the neonatal period.

The next section will focus on decomposing these results by demographic group, but it is important to note that our estimates are not driven by the mortality outcomes of black infants (who have long been observed to have relatively poor birth outcomes in the US): Appendix Table C.1 (row 5) replicates Table 3 excluding blacks from our US sample, and a similar post-neonatal disadvantage is still evident.[5]

Relative to the average death rates, the US disadvantage in the postneonatal period is very large. Over the period from 1 to 12 months, the death rate in Austria was 0.81 per 1000. Based on the coefficients from Table 3, the predicted death rate in the US with the same conditions at birth would be 1.89 per 1000 births, more than twice as large. This is especially striking since Austria is very close to the US on birth weight distribution (see Figure 2b) and also quite similar on neonatal mortality. Effectively, despite starting with very similar conditions at birth and the same neonatal outcomes, Austria vastly outpaces the US starting at 1 month of age.

Together, this evidence suggests that aggregate comparisons are misleading. Whereas in the aggregate data the US disadvantage appears to be more important in the neonatal than postneonatal period, in fact the opposite appears to be true. Our primary analyses rely on the comparison with Finland and Austria, where we were able to obtain comparable micro-data. However, for two other countries – the UK and Belgium – we have sufficiently detailed aggregate data to be able to explore the basic patterns documented in this section in a comparably reported sample. In Appendix A we replicate Tables 2 and 3 using these data. The basic patterns – and in particular the importance of the postneonatal period – are evident in these comparisons as well.

[5] An additional possibility is that the results could be driven by first births, if mothers are less informed about appropriate care for newborns on their first birth. The data suggest this explanation does not account for the patterns in the data: Appendix Table C.1 (row 6) replicates Table 3 on the sample excluding first births, and the resulting estimates are quite similar. Finally, row 7 of Appendix Table C.1 shows these results after we add multiple births back into the sample, with again very similar results.

3.4 Causes of Death

Before moving on to a demographic decomposition, a natural question is which causes of death account for the US disadvantage in the postneonatal period. We observe cause of death in our data, but a central issue – difficult to resolve – is differences in cause of death coding across countries. For example, Austria codes many postneonatal deaths as being due to low birth weight; virtually no deaths in either the US or Finland use this code in this time period. In all three countries a very large share of deaths – perhaps as much as a third – are in small categories which aggregate to "other" but are not very informative on their own. Further, because correct coding of SIDS deaths is difficult (Kim et al. 2012; Pearson et al. 2011), SIDS as a cause of death may be difficult to interpret.

With these caveats, Table 4 shows postneonatal death rates in six cause of death categories. We calculate the postneonatal death rate (per 1000) for each cause group for each country and then calculate the US-Finland difference and the US-Austria difference. We also calculate the percent increase over the Finnish or Austrian death rate. These conclusions are very similar if we look separately by country and socioeconomic group (results not shown).

These cause of death results are similar for Austria and Finland. Congenital abnormalities play almost no role. In raw difference terms SIDS and other sudden deaths are the most important, although this is largely because these causes account for the largest number of deaths. Accidents seem to play an important role in both raw and share terms. As a share, deaths from assault and respiratory infections (largely pneumonia) are much higher in the US, although these represent a small number of deaths. There is no clear smoking gun from this table, although it does suggest that congenital abnormalities are unimportant.

4 Demographics of US Postneonatal Disadvantage

It is well known that – relative to Europe – the US has higher inequality on many metrics (Bertola and Ichino, 1995). Given this, a natural question is whether the composition of the US IMR disadvantage is explained by worse outcomes among less advantaged households in the US relative to Europe.[6] For example, a key focus of a recent National Research Council report was the question of whether even highly advantaged Americans are in worse health than their counterparts in peer countries, or whether worse average health outcomes in the US only reflect higher levels of health inequality (National Research Council 2013).

We begin by asking whether particular segments of the US population account for an outsize share of the US disadvantage. We focus on postneonatal mortality, and undertake a simple exercise in the spirit of an Oaxaca decomposition. Denote the group X share in country Y as S_X^Y and the group X death rate in country Y as

[6] A large literature – see, for example Avendano (2012) – has estimated the cross-country relationship between income inequality and infant mortality, tending to find a strong positive cross-sectional correlation that is not always robust to alternative specifications (such as country fixed effect models).

D_X^Y. The importance of group X in explaining the US versus European country E disadvantage is:

$$\frac{S_X^{US} D_X^{US} - S_X^{US} D_X^E}{IMR_{US} - IMR_E}$$

Intuitively, this calculates the share of the postneonatal IMR gap between the US and country E that would be closed if the death rates for group X in the US were the same as the death rates for group X in country E. This calculation ignores the possibility that the share of individuals in group X differ across countries; this would be the other side of the decomposition. In practice, other than race (which we only measure in the US), the shares are very similar across countries and the major differences are in death rates.

Table 5 shows the results of this calculation. We consider a number of subgroups: race, education/occupation status, marital status, and age group.[7] Panel A of the table shows these shares when we look at raw data on deaths. Panel B shows the shares after we adjust for birth weight categories (i.e. shares of the residual variation explained). This table also reports the share of individuals in each group in the US. Groups with more representation in the population will naturally be more important in explaining the overall difference. By comparing the share that a group explains to their share in the population we can understand whether some groups explain more *relative to* their share.

It is clear from this table that some groups contribute more than others to the difference, and that this conclusion is fairly insensitive to the birth weight adjustment (that is, the estimates in Panel A and Panel B are quite similar). Perhaps most striking is the breakdown by education/occupation. Nearly all of the difference across countries is accounted for by the bottom three-quarters of the distribution. Echoing the education/occupation results, we find that unmarried mothers and African-American mothers account for an outsize share of the infant mortality difference across countries. Low birth weight babies (under 2500 grams) also account for a large share of the difference. This is not because the US does poorly conditional on birth weight, but simply because within these low birth weight groups the US babies are (on average) *lower* birth weight and therefore face higher mortality risks.

The evidence in Table 5 shows that, indeed, certain groups play a larger role than others in the US disadvantage. But it does not directly address the question of whether there are groups in the US that do as well as comparable groups in Europe. To do that we use the decomposition in Table 5 to identify an "advantaged" demographic: mothers who are high education/occupation, married and white.[8] We then compare the mortality profile of this group, and the corresponding less advantaged group, across the three countries. It is worth noting in this analysis that the comparison with Austria is, again, likely to be the most informative because in both the US and Austria we have data on education. In Finland, we use occupation as a proxy for educational level, which is likely to be correlated but is less comparable.

[7] Since we do not observe a measure of race in Finland or Austria, when we consider the breakdown by race we focus on all non-black individuals in the US and compare to all individuals in comparison countries. This effectively asks how mortality would change if the death rate for whites was the same as in Finland or Austria.

[8] This group is 22% of the US, 18.5% of Austria and 16.2% of Finland.

We show visual evidence on the cross-country/cross-group comparison in Figure 5, which shows cumulative deaths rates in the three countries for the two education/occupation groups. In Figure 5a, the advantaged individuals, there appears to be virtually no difference in death rates. In contrast, for the lower portion of the distribution (Figure 5b) the US death rate is much higher. In the postneonatal period the death rate for this group in the US is 2.4 per 1000, versus 0.90 in Austria and 0.97 in Finland.

We explore this in a regression form by estimating regressions analogous to those in Column 3 of Table 3 but including an interaction between an indicator variable for the US and an indicator variable for our advantaged definition. We can then test whether individuals in the advantaged group look different in the US than elsewhere. This estimation is done in Table 6. Panel A considers postneonatal mortality, where the US disadvantage arises. Relative to both Austria (Column 1) and Finland (Column 2), the main effect of US is large and positive and the interaction is large and negative. The advantaged group in the US cannot be distinguished from the similar group in Finland; they have effectively the same mortality rate. Austria retains some advantage relative to the US in all groups, but the difference is much smaller – 0.2 deaths per 1000 versus 1.35 deaths per 1000 – in the advantaged group.[9]

Interestingly, Panel B demonstrates that the US *does not* show excess inequality in neonatal mortality. The main effect of the US in both columns is negative, indicating that less advantaged groups in the US do *better* than their counterparts in Europe conditional on circumstances at birth (this is marginally significant for Finland). The interaction effect is small and insignificant in both columns and of differing sign.

Overall, the evidence in Table 6 (and in Table 5 and Figure 5) suggests that the higher postneonatal mortality in the US is due entirely, or almost entirely, to high mortality among less advantaged groups. Well-off individuals in all three countries have similar infant mortality rates. Another way to state this is in the context of within country inequality. In both Finland and Austria, postneonatal mortality rates are extremely similar across groups with varying levels of advantage, either unconditionally or (more starkly) conditional on conditions at birth. This pattern is confirmed graphically in Appendix Figure C.1. In contrast, there is tremendous inequality in the US, with lower education groups, unmarried and African-American women having much higher infant mortality rates.

5 Discussion and Conclusion

The goal in understanding the US infant mortality disadvantage relative to Europe is to better understand what policy levers might be effective in reducing infant mortality in the US. Our results on neonatal mortality strongly suggest that differential access to technology-intensive medical care provided shortly after birth is unlikely to explain the US IMR disadvantage. This conclusion is, perhaps, surprising in light of evidence that much of the

[9]In Appendix Tables C.2 and C.3 we replicate Panel A of table varying the definition of advantaged. Appendix Table C.2 uses only the education/occupation variable and C.3 uses education/occupation and married (but not race). The results are very similar. In particular, leaving race out of the definition makes virtually no difference, reinforcing our earlier point that these results are not driven by black/white differences in the US.

decline in infant mortality in the 1950 to 1990 period was due to improvement in neonatal medical technologies (Cutler and Meara (2000)). However, a variety of evidence suggests that access to technology-intensive post-birth medical care should affect mortality risks during the neonatal period, rather than during the postneonatal period: median time spent in the neonatal intensive care unit (NICU) is 13 days (March of Dimes 2011), and this care is thought to primarily affect neonatal mortality (see, for example, Rudolph and Borker (1987), Budetti et al. (1981), and Shaffer (2001)). Consistent with this assertion, Almond et al. (2010) analyze the mortality consequences of incremental increases in medical expenditures for at-risk infants (including NICU admission as well as other expenditures), and find that the mortality benefits of additional medical care are concentrated in the first 28 days of life. Our results suggest that if anything the US has a mortality *advantage* during the neonatal period.

Instead, the facts documented here suggest that, in general, if the goal is to reduce infant mortality, then policy attention should focus on either preventing preterm births or on reducing postneonatal mortality. Although the former has received a tremendous amount of policy focus (MacDorman and Mathews (2009); Wilcox et al. (1995)), the latter has - to the best of our knowledge - received very little attention. Our estimates suggest that decreasing postneonatal mortality in the US to the level in Austria would lower US death rates by around 1 death per 1000. Applying a standard value of a statistical life of US$7 million, this suggests on a standard cost-benefit test it would be worth spending up to $7000 per infant to achieve this gain. If policies were able to focus on individuals of lower socioeconomic status – given our estimates that advantaged groups do as well in the US as elsewhere – even higher levels of spending per mother targeted might be justified.

Identifying particular policies which could be effective is beyond the scope of this paper and is an area that deserves more research attention. One policy worth mentioning is home nurse visits. Both Finland and Austria, along with much of the rest of Europe, have policies which bring nurses or other health professionals to visit parents and infants at home. These visits combine well-baby checkups with caregiver advice and support. While such small scale programs exist in the US, they are far from universal, although provisions of the Affordable Care Act will expand them to some extent. Randomized evaluations of such programs in the US have shown evidence of mortality reductions, notably from causes of death we identify as important such as SIDS and accidents (Olds et al. 2007).

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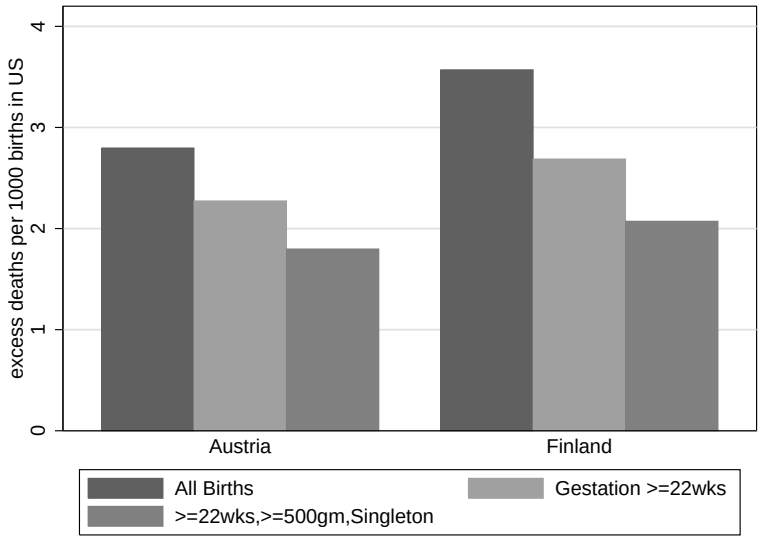
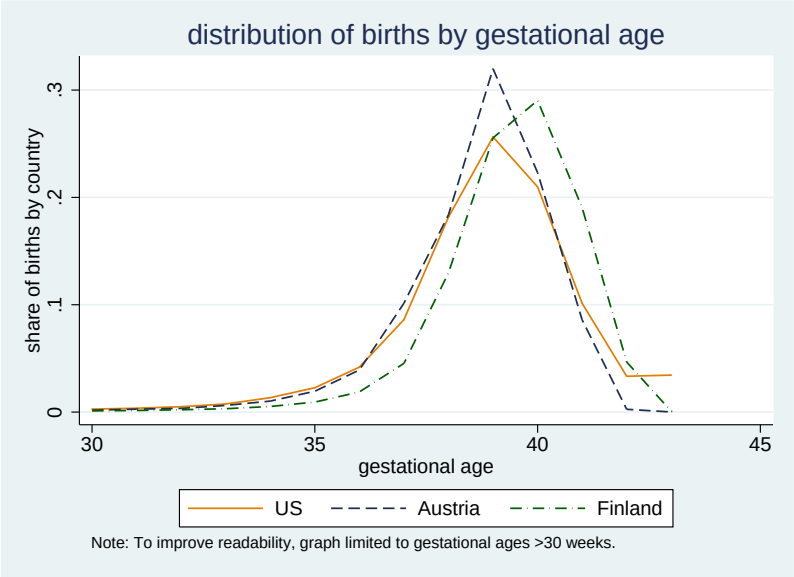
Figure 1: **US IMR disadvantage: Full sample and restricted samples**



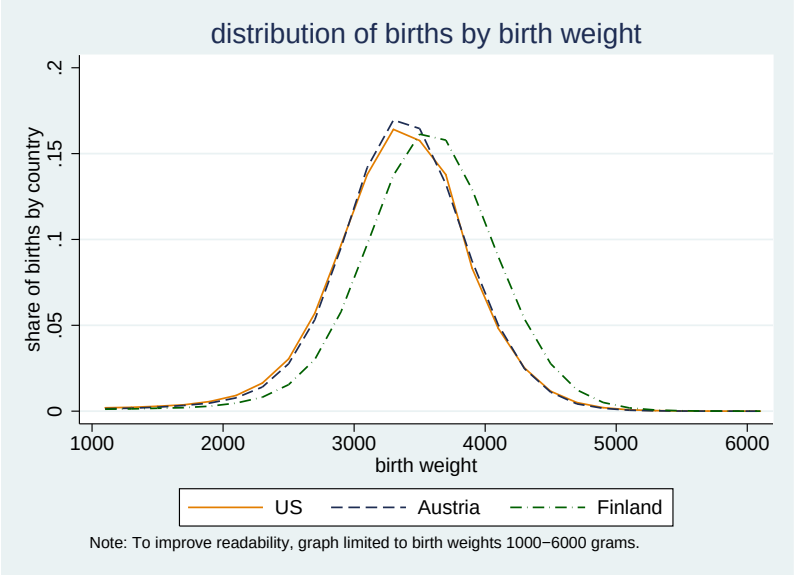
Notes: This figure shows the number of excess US deaths per 1000 births compared to Austria and Finland overall (the first set of bars), in the sample restricted to births >=22 weeks of gestation (second set of bars), and in the sample restricted to singleton births >=22 weeks of gestation and >=500 grams (third set of bars).

Figure 2: **Distribution of births by gestational age and birth weight, by country**

(a) Gestational age

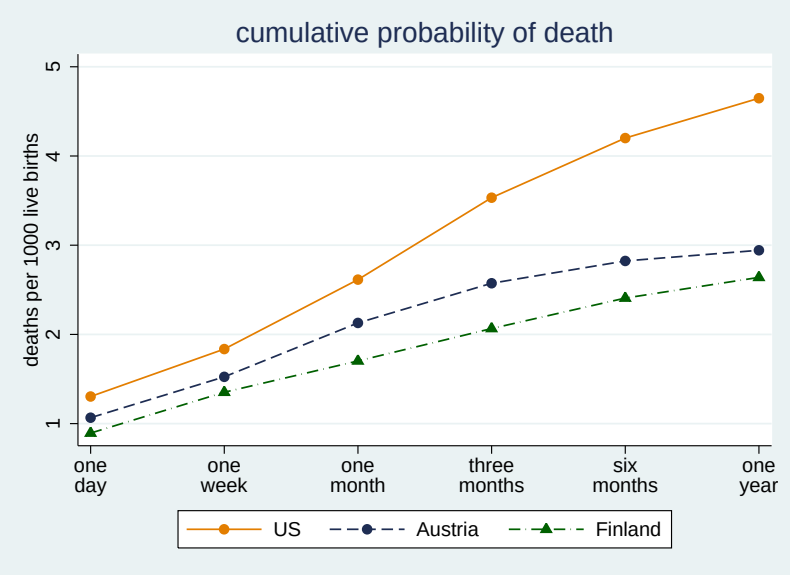


(b) Birth weight



Notes: These figures show the distribution of gestational age and birth weight for each country. For ease of presentation, Panel A is limited to births >30 weeks and Panel B is limited to birth weights between 1000 and 6000 grams. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with both birth weight and gestational age observed.

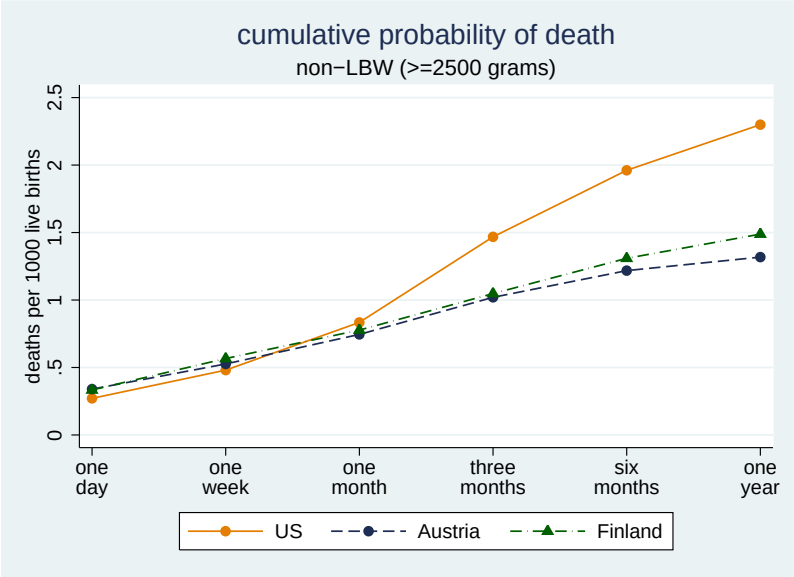
Figure 3: **Cumulative probability of death, by country**



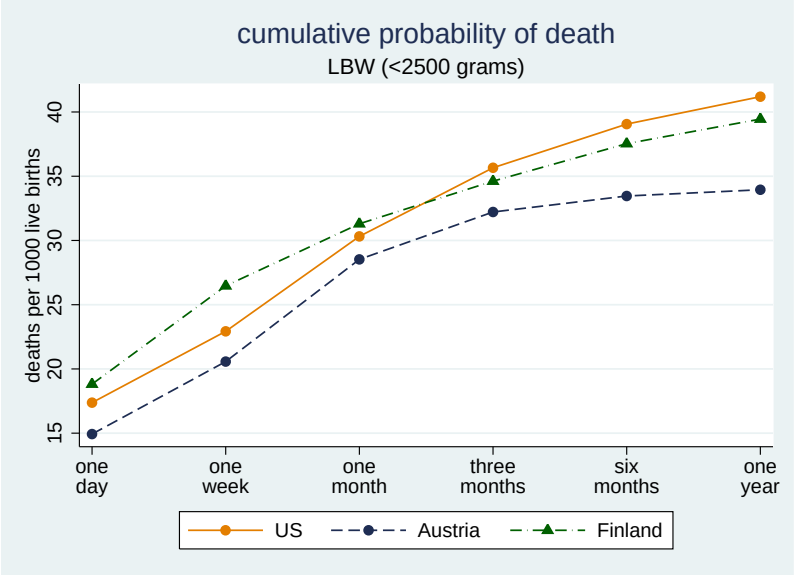
Notes: This figure shows the cumulative probability of death, by country and timing of death, unconditional on conditions at birth. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with both birth weight and gestational age observed.

Figure 4: **Cumulative probability of death, by country, by birth weight**

(a) Normal birth weight only (>=2500 grams)



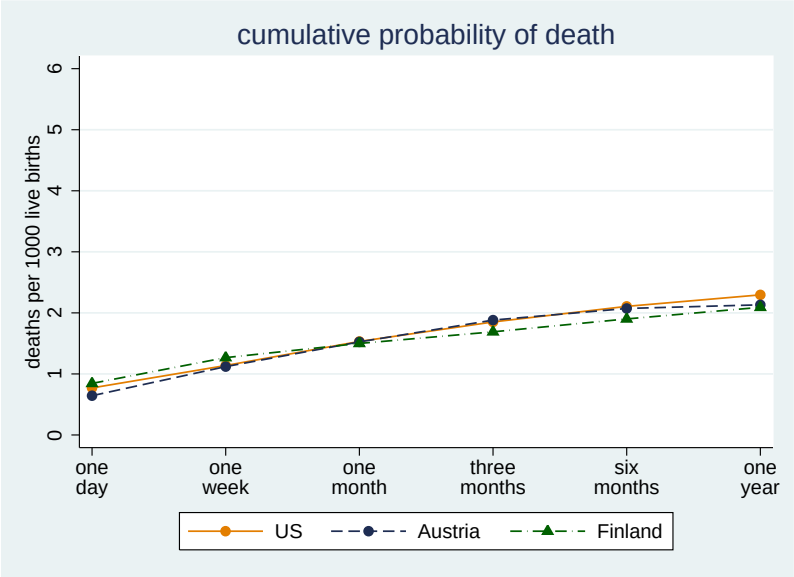
(b) Low birth weight only (<2500 grams)



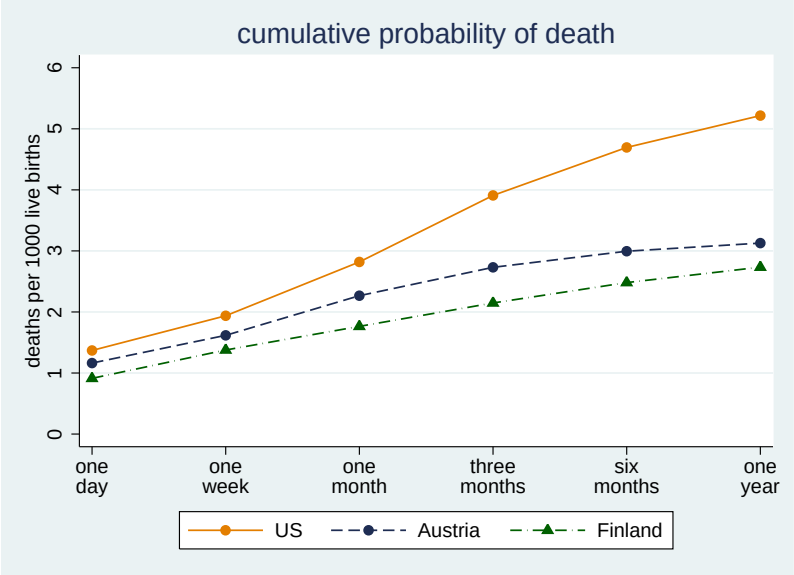
Notes: These figures show the cumulative probability of death, by country, timing of death, and birth weight. In Panel A, the sample includes normal birth weight babies (≥2500 grams). In Panel B, the sample includes low birth weight babies (<2500 grams). Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with both birth weight and gestational age observed.

Figure 5: **Cumulative probability of death, by country, by group**

(a) Advantaged group



(b) Less advantaged group



Notes: These figures show the cumulative probability of death, by country, timing of death, and group. "Advantaged" is as defined in the text (mothers who are high education/occupation, married and white). Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with no missing covariates.

Table 1: **Summary statistics**

	(1) United States	(2) Austria	(3) Finland
1(death within 1 year), per 1000 births, full sample	6.780	3.983	3.209
# of observations	24,484,028	466,227	339,312
	Panel A: Main Sample		
1(death within 1 year), per 1000 births, restricted sample	4.647	2.943	2.640
Gestational age (weeks)	38.780	38.602	39.376
Birth weight (grams)	3,331.933	3,344.803	3,549.909
# of observations	23,411,153	451,920	327,732
	Panel B: Demographic Sample		
1(death within 1 year), per 1000 births, restricted sample	4.553	2.943	2.630
Gestational age (weeks)	38.782	38.602	39.378
Birth weight (grams)	3,332.641	3,344.803	3,552.534
1(infant is male)	0.512	0.512	0.513
Mother's age (years)	27.402	28.754	29.514
1(mother is black)	0.149	–	–
1(mother is married)	0.653	0.653	0.599
1(mother is high education/occupation)	0.257	0.266	0.218
# of observations	23,113,240	451,920	292,786

Notes: Race is reported only in the US data. High education/occupation is as defined in the text. Data for all countries covers 2000-2005. The first row contains the whole sample. Panel A is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with birth weight and gestational age observed. Panel B limits to observations with no missing demographic covariates.

Table 2: **Accounting for differences: US versus Europe**

	(1) Birth weight	(2) <1 month mortality	(3) 1-12 month mortality
Panel A: Full sample			
US actual mortality	4.64	4.64	4.64
US predicted mortality, Austrian characteristics	4.08	4.62	3.51
US predicted mortality, Finnish characteristics	3.17	4.84	3.90
Difference vs Austria: Predicted - actual	**-0.56**	**-0.02**	**-1.13**
Difference vs Finland: Predicted - actual	**-1.47**	**0.20**	**-0.74**
Panel B: Normal birth weight (>=2500 grams)			
US actual mortality		2.30	2.30
US predicted mortality, Austrian characteristics		2.22	1.41
US predicted mortality, Finnish characteristics		2.40	1.68
Difference vs Austria: Predicted - actual		**-0.08**	**-0.89**
Difference vs Finland: Predicted - actual		**0.10**	**-0.62**
Panel C: Low birth weight (<2500 grams)			
US actual mortality		41.19	41.19
US predicted mortality, Austrian characteristics		42.01	36.03
US predicted mortality, Finnish characteristics		42.93	38.43
Difference vs Austria: Predicted - actual		**0.82**	**-5.16**
Difference vs Finland: Predicted - actual		**1.74**	**-2.76**

Notes: The first column shows predicted mortality if the US had the Austrian or Finnish birth weight distribution along with the US mortality rate conditional on birth weight. The second column shows predicted mortality with the US birth weight distribution and US postneonatal mortality rates, and either Austrian or Finnish neonatal mortality rates. The third column shows predicted mortality with the US birth weight distribution and neonatal mortality rates, and either Austrian or Finnish postneonatal mortality rates. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with birth weight and gestational age observed.

Table 3: **Cross country differences in mortality**

	Panel A: US vs. Finland					
	(1)		(2)		(3)	
Mortality (in 1000s):	< 1 week		Week to 1 month		1 to 12 months	
United States	-0.277	***	0.163	***	0.646	***
	(<.001)		(<0.001)		(<0.001)	
Cumulative effect, US	-0.277		-0.114		0.532	
# of observations	23,738,885		23,695,461		23,667,125	
Finland mortality level	1.351		0.351		0.938	
Cumulative mortality, Finland	1.351		1.702		2.640	
	Panel B: US vs. Austria					
	(1)		(2)		(3)	
Mortality (in 1000s):	< 1 week		Week to 1 month		1 to 12 months	
United States	-0.018		0.067	*	1.083	***
	(0.736)		(0.063)		(<0.001)	
Cumulative effect, US	-0.018		0.049		1.132	
# of observations	23,863,073		23,819,403		23,800,909	
Austria mortality level	1.524		0.605		0.816	
Cumulative mortality, Austria	1.524		2.129		2.943	

Notes: This table shows differences across countries in mortality, using either Finland (Panel A) or Austria (Panel B) as the omitted country. The regressions adjust for (1) 500-gram birth weight category cells; and (2) indicator variables for year of birth. The regression results are conditional on reaching the minimum age: deaths up to 1 week; deaths from 1 week to 1 month, conditional on surviving to 1 week, etc. Coefficients are in units of 1000 deaths: a coefficient of 1 indicates an increase of 1 death in 1000 births. Each panel also shows the cumulative effect by country (the sum of the coefficients up to that point). Robust standard errors in parentheses. ***significant at 1% level, **significant at 5% level, * significant at 10% level. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with birth weight and gestational age observed.

Table 4: **Postneonatal cause of death, by country and group**

Cause of death:	(1) Congenital abnormalities and low birthweight	(2) Respiratory	(3) SIDS and other sudden deaths	(4) Accident	(5) Assault	(6) Other
			Panel A: Country Differences			
US	0.380	0.068	0.699	0.208	0.064	0.613
Finland	0.325	0.021	0.226	0.044	0.003	0.287
Austria	0.377	0.007	0.185	0.030	0.013	0.175
US-Finland						
Raw Difference	*0.055*	*0.047*	*0.473*	*0.164*	*0.061*	*0.326*
As Share of Finland	*17%*	*224%*	*209%*	*373%*	*2033%*	*114%*
US-Austria						
Raw Difference	*0.003*	*0.061*	*0.514*	*0.178*	*0.051*	*0.438*
As Share of Austria	*1%*	*871%*	*278%*	*593%*	*392%*	*250%*
			Panel B: Country-by-Group Differences			
US Advantaged	0.236	0.016	0.153	0.054	0.011	0.293
US Less Advantaged	0.422	0.083	0.859	0.252	0.080	0.707
Finland Advantaged	0.230	0	0.053	0.018	0	0.177
Finland Less Advantaged	0.411	0.008	0.216	0.033	0.016	0.175
US-Finland						
Raw Difference-in-Difference	*0.005*	*0.059*	*0.543*	*0.183*	*0.053*	*0.416*
As Share of Finland Average	*2%*	*281%*	*240%*	*416%*	*1767%*	*145%*
Austria Advantaged	0.275	0	0.085	0.021	0	0.211
Austria Less Advantaged	0.335	0.024	0.253	0.049	0.004	0.302
US-Austria						
Raw Difference-in-Difference	*0.126*	*0.043*	*0.538*	*0.170*	*0.065*	*0.323*
As Share of Austria Average	*33%*	*614%*	*291%*	*567%*	*500%*	*185%*

Notes: This table shows the difference in postneonatal mortality from each cause across countries and across groups. All means are computed on the sample of infants alive at 1 month. "Advantaged" is as defined in the text (mothers who are high education/occupation, married and white). Means are in units of 1000 deaths. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with no missing covariates.

Table 5: **Subgroup breakdown: Postneonatal mortality**

	(1) US versus Austria	(2) US versus Finland
Panel A: Non-residualized birth weight		
Non-Black (85%)	63%	61%
High education/occupation (25%)	7%	5%
Low education/occupation (75%)	93%	96%
Unmarried (35%)	66%	68%
Married (65%)	34%	33%
< =20 years (16%)	22%	22%
21-35 years (73%)	65%	64%
35+ years (11%)	6%	4%
500 to < 1500 grams (0.8%)	10%	11%
1500 to < 2500 grams (5%)	16%	2%
2500 to < 3500 grams (56%)	49%	36%
3500 to < 4500 grams (37%)	20%	19%
4500+ grams (1.3%)	0%	1%
Panel B: Residualized birth weight		
Non-Black (85%)	71%	62%
High education/occupation (25%)	7%	-2%
Low education/occupation (75%)	93%	103%
Unmarried (35%)	64%	78%
Married (65%)	36%	23%
< =20 years (16%)	21%	23%
21-35 years (73%)	66%	62%
35+ years (11%)	7%	1%

Notes: This table shows the share of the postneonatal mortality differences explained by sub-groups. Figures in parentheses show the share of the US population in that group. To generate Panel B we residualize with respect to 500-gram birth weight bins. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with no missing covariates.

Table 6: **Cross country differences in postneonatal and neonatal mortality, by group**

Panel A: Postneonatal Mortality				
	(1)		(2)	
	US versus Austria		US versus Finland	
United States	1.349	***	0.920	***
	(<0.001)		(<0.001)	
Advantaged	-0.076		-0.296	**
	(0.432)		(0.021)	
United States × Advantaged	-1.163	***	-0.940	***
	(<0.001)		(<0.001)	
# of observations	23,505,784		23,347,108	
High SES, US vs. Europe	0.030		0.853	
Panel B: Neonatal Mortality				
	(1)		(2)	
	US versus Austria		US versus Finland	
United States	-0.001		-0.149	*
	(0.993)		(0.072)	
Advantaged	-0.226		-0.080	
	(0.124)		(0.676)	
United States × Advantaged	0.030		-0.116	
	(0.837)		(0.548)	
# of observations	23,565,160		23,406,026	
High SES, US vs. Europe	0.816		0.128	

Notes: This table shows differences across countries in mortality by advantaged versus less advantaged group. The regressions adjust for (1) 500-gram birth weight category cells; and (2) indicator variables for year of birth. The regression results are conditional on surviving to 1 month of age. "Advantaged" is as defined in the text (mothers who are high education/occupation, married and white). Coefficients are in units of 1000 deaths: a coefficient of 1 indicates an increase of 1 death in 1000 births. Robust standard errors in parentheses. ***significant at 1% level, **significant at 5% level, * significant at 10% level. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with no missing covariates.

Appendix A: Evidence from UK and Belgium

Our primary results rely on Finland and Austria because those are the counties for which we have micro-data which is directly comparable to the US, and which includes demographic information. However, it is possible to complete some of our analyses – in particular, Tables 2 and 3 – with more aggregated data. In fact, the data requirements are still somewhat stringent. To ensure comparability we need data which is limited to singleton births, at or after 22 week of gestation and at least 500 grams in birth weight (or data disaggregated in a way such that we can select this sample). In addition, we need to see birth weight at some level of disaggregation – to match our main analyses this would be in bins of 500 grams or finer – and need to observe a breakdown of age-of-death within the first year. We were able to obtain data matching (or nearly matching) these conditions from two additional countries: the UK and Belgium. In this appendix, we replicate Tables 2 and 3 with these data and show that our conclusions from the main text do not appear to be specific to the use of Austria and Finland as peer countries.

Data from the UK was generated through a special request to the UK Office of National Statistics. They limited the data to singleton births, at or after 22 week of gestation and at least 500 grams in birth weight and provided us with data on births by 500 gram bins matched to deaths at less than one day, 1 day to 1 week, 1 week to 1 month, 1 to 3 months, 3 to 6 months and 6 to 12 months. The birth weight cells are capped at 4000 grams.

Data for Belgium was downloaded from online records through the Centre for Operational Research in Public Health. Data is provided in 100 gram bins with counts of births and deaths and the ability to limit to singleton births. Belgian reporting standards limit the data to gestational ages of at or after 22 weeks. Information is provided on deaths in the first week, 1 week to 1 month, 1 to 6 months and 6 to 12 months.

Both the UK and Belgium have lower infant mortality in the comparable sample than the US. Recall the US IMR in this sample is 4.64 per 1000. The figures for the UK and Belgium are 3.43 per 1000 and 3.66 per 1000, respectively.

Table A.1 below replicates Table 2 using these countries. The basic results are very similar to what we see in Austria and Finland. Focusing on Panel A, we see that both conditions at birth and the postneonatal period play an important role. Relative to the UK, the postneonatal period is much more important than conditions at birth. The role of the two periods is more similar in Belgium, with conditions at birth being slightly more important. In the neonatal period the US and UK are comparable. The US has much better higher survival in the neonatal period than Belgium.

Table A.2 replicates Table 3, with Panel A comparing the US to the UK and Panel B comparing the US to Belgium. Both comparisons paint an extremely similar picture to the estimates presented in the main text: relative to both comparison countries, the US has an advantage in the first week, and a large disadvantage in the postneonatal period.

Table A.1: **Accounting for differences: Alternative comparison countries**

	(1) Birth weight	(2) <1 month	(3) 1-12 month
Panel A: Full sample			
US actual mortality	4.64	4.64	4.64
US predicted mortality, UK characteristics	4.23	4.56	3.93
US predicted mortality, Belgian characteristics	3.91	4.99	4.17
Difference vs UK: Predicted - actual	**-0.41**	**-0.08**	**-0.71**
Difference vs Belgium: Predicted - actual	**-0.73**	**0.35**	**-0.47**
Panel B: Normal birth weight (> =2500 grams)			
US actual mortality		2.30	2.30
US predicted mortality, UK characteristics		2.31	1.62
US predicted mortality, Belgian characteristics		2.36	1.95
Difference vs UK: Predicted - actual		**0.01**	**-0.69**
Difference vs Belgium: Predicted - actual		**0.06**	**-0.35**
Panel C: Low birth weight (< 2500 grams)			
US actual mortality		41.19	41.19
US predicted mortality, UK characteristics		39.57	40.10
US predicted mortality, Belgian characteristics		46.04	38.77
Difference vs UK: Predicted - actual		**-1.62**	**-1.09**
Difference vs Belgium: Predicted - actual		**4.85**	**-2.42**

Notes: This table shows the actual mortality in the US and predicted mortality with UK or Belgian characteristics. The first column shows predicted mortality if the US had the UK or Belgian birth weight distribution along with the US mortality rate conditional on birth weight. The second column shows predicted mortality with the US birth weight distribution and US postneonatal mortality rates, and either UK or Belgian neonatal mortality rates. The third column shows predicted mortality with the US birth weight distribution and neonatal mortality rates, and either UK or Belgian postneonatal mortality rates. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams. UK birth weight is top-coded at 4000 grams.

Table A.2: **Cross country differences in mortality: Alternative comparison countries**

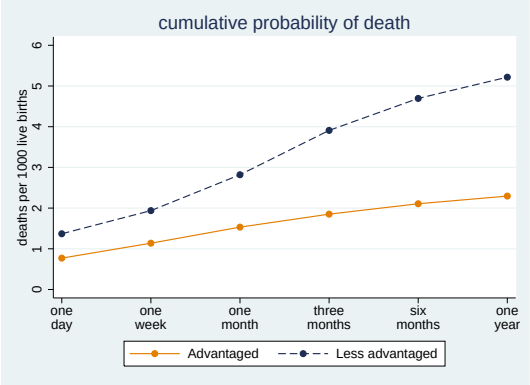
	Panel A: US vs. UK					
	(1)		(2)		(3)	
Mortality (in 1000s):	< 1 week		Week to 1 month		1 to 12 months	
United States	-0.026		0.056	***	0.651	***
	(0.020)		(0.013)		(0.020)	
Cumulative effect, US	-0.026		0.030		0.681	
# of observations	28,419,098		28,326,060		28,301,230	
UK mortality level	1.539		0.608		1.280	
Cumulative mortality, UK	1.539		2.147		3.427	
	Panel B: US vs. Belgium					
	(1)		(2)		(3)	
Mortality (in 1000s):	< 1 week		Week to 1 month		1 to 12 months	
United States	-0.263	***	0.042		0.457	***
	(0.048)		(0.030)		(0.047)	
Cumulative effect, US	-0.263		-0.221		0.236	
# of observations	24,078,850		24,034,768		24,016,169	
Belgian mortality level	1.620		0.594		1.452	
Cumulative mortality, Belgium	1.620		2.214		3.666	

Notes: This table shows differences across countries in mortality, using either the UK (Panel A) or Belgium (Panel B) as the omitted country. The regressions adjust for (1) 500-gram birth weight category cells; and (2) indicator variables for year of birth. The regression results are conditional on reaching the minimum age: deaths up to 1 week; deaths from 1 week to 1 month, conditional on surviving to 1 week, etc. Coefficients are in units of 1000 deaths: a coefficient of 1 indicates an increase of 1 death in 1000 births. Each panel also shows the cumulative effect by country (the sum of the coefficients up to that point). Robust standard errors in parentheses. ***significant at 1% level, **significant at 5% level, * significant at 10% level. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams. UK birth weight is top-coded at 4000 grams.

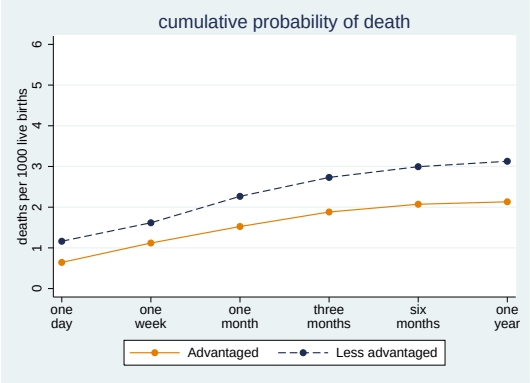
Appendix C: Additional tables and figures

Figure C.1: **Cumulative probability of death, by country and group**

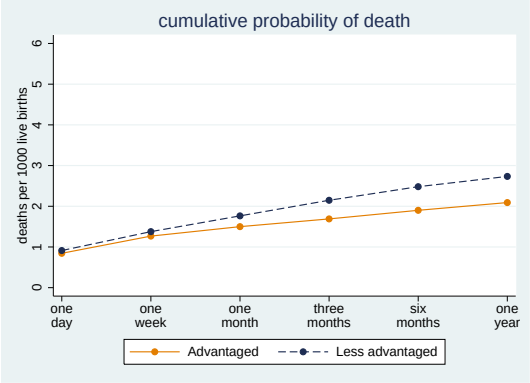
(a) United States



(b) Austria



(c) Finland



Notes: These figures show the cumulative probability of death, by country, timing of death, and group. "Advantaged" is as defined in the text (mothers who are high education/occupation, married and white). Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with no missing covariates.

Table C.1: **Cross country differences in mortality: Robustness**

	Panel A: US vs. Finland					
	(1)		(2)		(3)	
Sample restriction	< 1 week		Week to 1 month		1 to 12 months	
Baseline	-0.277	***	0.147	***	0.671	***
	(0.067)		(0.035)		(0.056)	
Exclude Births < 1000gr	-0.269	***	0.124	***	0.601	***
	(0.054)		(0.029)		(0.052)	
Demographic controls	-0.320	***	0.142	***	0.515	***
	(0.063)		(0.033)		(0.054)	
Exlude APGAR < 9	0.018		0.113	***	0.640	***
	(0.037)		(0.038)		(0.085)	
Exclude US Blacks	-0.219	***	0.144	***	0.496	***
	(0.062)		(0.033)		(0.054)	
Exclude first births	-0.422	***	0.111	**	0.675	***
	(0.083)		(0.044)		(0.074)	
Include multiple births	-0.351	***	0.151	***	0.697	***
	(0.066)		(0.034)		(0.054)	
	Panel B: US vs. Austria					
	(1)		(2)		(3)	
Sample restriction	< 1 week		Week to 1 month		1 to 12 months	
Baseline	-0.018		0.067		1.083	***
	(0.736)		(0.063)		(<0.001)	
Exclude Births < 1000gr	0.034		0.140	***	1.051	***
	(0.044)		(0.028)		(0.040)	
Demographic controls	-0.079		0.036		0.916	***
	(0.056)		(0.036)		(0.043)	
Exlude APGAR < 9	-0.106	***	0.082	***	0.965	***
	(0.027)		(0.024)		(0.037)	
Exclude US Blacks	0.078		0.049		0.904	***
	(0.056)		(0.036)		(0.043)	
Exclude first births	-0.052		0.061		1.127	***
	(0.074)		(0.048)		(0.062)	
Include multiple births	-0.029		0.035		1.112	***
	(0.059)		(0.039)		(0.044)	

Notes: This table shows differences across countries in mortality, using either Finland (Panel A) or Austria (Panel B) as the omitted country, as in Table 3. Each cell shows the key estimate of interest from a different regression equation: the baseline as in Table 3 (row 1 in each panel); excluding births less than 1000 grams (row 2 in each panel); including demographic controls (a quadratic in mother's age in years; an indicator variable for whether the mother is currently married; an indicator variable for whether the child is male; and an indicator variable for high education/occupation as defined in the text; row 3 in each panel); excluding infants with APGAR scores less than 9 (row 4 in each panel); excluding US Blacks (row 5 in each panel); excluding first births (row 6 in each panel); and adding in multiple births (row 7 in each panel). The regressions adjust for (1) 500-gram birth weight category cells; and (2) ; indicator variables for year of birth. The regression results are conditional on reaching the minimum age: deaths up to 1 week; deaths from 1 week to 1 month, conditional on surviving to 1 week, etc. Coefficients are in units of 1000 deaths: a coefficient of 1 indicates an increase of 1 death in 1000 births. Robust standard errors in parentheses. ***significant at 1% level, **significant at 5% level, * significant at 10% level. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at $\geq$22 weeks of gestation and $\geq$500 grams with birth weight and gestational age observed in all rows, and no missing covariates in rows 2 through 5 of each panel.

Table C.2: **Cross country differences in mortality, by group (education only)**

	(1) US versus Austria		(2) US versus Finland	
United States	1.350	***	0.946	***
	(0.053)		(0.066)	
High SES	-0.174	**	-0.248	**
	(0.086)		(0.122)	
United States × High SES	-1.050	***	-0.976	***
	(0.087)		(0.123)	
# of observations	23,505,784		23,347,108	
High SES, US vs. Europe	<.001		0.776	

Notes: This table shows differences across countries in mortality by advantaged versus less advantaged group, as in Table 6, except that "advantaged" here is defined only as high education/occupation. The regressions adjust for (1) 500-gram birth weight category cells; and (2) indicator variables for year of birth. The regression results are conditional on surviving to 1 month of age. "Advantaged" is as defined in the text (mothers who are high education/occupation, married and white). Coefficients are in units of 1000 deaths: a coefficient of 1 indicates an increase of 1 death in 1000 births. Robust standard errors in parentheses. ***significant at 1% level, **significant at 5% level, * significant at 10% level. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with no missing covariates.

Table C.3: **Cross country differences in mortality, by group (education+married only)**

	(1) US versus Austria		(2) US versus Finland	
United States	1.366	***	0.937	***
	(0.049)		(0.064)	
High SES and married	-0.076		-0.296	**
	(0.097)		(0.128)	
United States × (High SES and married)	-1.160	***	-0.945	***
	(0.098)		(0.130)	
# of observations	23,505,784		23,347,108	
High SES and married, US vs. Europe	0.020		0.938	

Notes: This table shows differences across countries in mortality by advantaged versus less advantaged group, as in Table 6, except that "advantaged" here is defined only as high education/occupation and married. The regressions adjust for (1) 500-gram birth weight category cells; and (2) indicator variables for year of birth. The regression results are conditional on surviving to 1 month of age. "Advantaged" is as defined in the text (mothers who are high education/occupation, married and white). Coefficients are in units of 1000 deaths: a coefficient of 1 indicates an increase of 1 death in 1000 births. Robust standard errors in parentheses. ***significant at 1% level, **significant at 5% level, * significant at 10% level. Data for all countries covers 2000-2005; as described in the text, the sample is limited to singleton births at ≥22 weeks of gestation and ≥500 grams with no missing covariates.