1. (50 points) A January 30, 2018 USA Today article titled “Immigration, infrastructure top Trump’s State of the Union initiatives” began with the following:

Major initiatives Trump outlined in his first State of the Union address Tuesday night include rebuilding the nation's dilapidated infrastructure and limiting the flow of immigrants who compete with American workers for jobs. “Together, we can reclaim our building heritage,” the president said. “We will build gleaming new roads, bridges, highways, railways, and waterways all across our land. And we will do it with American heart, American hands, and American grit.”

Both proposals can be measured in the billions. The president wants to spend $200 billion rebuilding roads, bridges, airports, railways, and water projects. The money would be used to generate federal, state, local and private resources totaling at least $1.5 trillion over the next decade. At the same time, Trump proposes spending $25 billion on immigration, including $18 billion for his prized but elusive wall along the Mexican border. The remainder would be used for new immigration and Border Patrol agents and technology on both the nation's borders.

You have been hired as a winter intern at the Congressional Budget Office (CBO), and on your first day of work your boss calls you into her office to discuss the links between infrastructure and immigration. Now that the midterm elections are over, she expects that infrastructure may be back on the table. And she wonders whether the President might have been on to something when he linked infrastructure and immigration in his State of the Union address. But she thinks he has the sign of this link wrong: according to her thinking, greater investment in infrastructure and more openness to immigration, not less, may go hand in hand to minimize the economic disruptions that would occur with either alone. She asks you to check her logic by using the Specific Factors Model and the Heckscher-Ohlin Model to answer a few questions. In answering these questions, you can assume that the US is a small open economy, trading freely with the large rest of the world and importing Manufactures and exporting Food, and that investment in infrastructure can be modeled as an increase in the US capital stock.

a) Assuming that in the short run the US economy can be represented by the Specific Factors Model, with Manufacturing-specific capital, Food-specific land, and with labor mobile between sectors, show that in the short run US land-owners would be hurt by infrastructure investment alone, but that if infrastructure investment were combined with the right amount of foreign labor immigration into the US, the real incomes of both US landowners and US labor could be left unchanged in the presence of the infrastructure investment in the short run. Hint: For the Specific Factors Model, you may assume that the added capital associated with infrastructure investment shifts up the MPP of labor curve in the Manufacturing sector.

b) Assuming that in the long run the US economy can be represented by the Heckscher-Ohlin Model, with Food the capital intensive good and Manufactures the labor intensive good, both of which the US produces, show that in the long run the US “industrial mix” (i.e., the ratio of Food production to Manufacturing production in the US) would have to adjust in the presence of infrastructure investment alone, but that if infrastructure investment were combined with the right amount of foreign labor immigration into the US, the US industrial mix need not change at all in the long run.
2. (30 points) In the US debate over immigration reform, there is some discussion of whether the US could benefit from a more selective immigration policy, in which potential immigrants with certain kinds of skills are given priority for entrance into the US. Using the Continuum-of-Goods Ricardian Trade Model, with the Home country representing the United States, and assuming that foreign workers who are employed in a given foreign industry \( z \) would bring knowledge of industry \( z \)’s foreign technology with them (and with this knowledge, help reduce the US unit labor requirement for that \( z \)) if they were allowed to emigrate to the US, show that the impact of immigration into the US could have different consequences for the real US wage depending on what industries (which interval of \( z \)’s) the foreign workers were originally employed in before they emigrated to the US. Hint: To answer this question, you can assume that, whatever interval of \( z \)’s the foreign workers come from when they emigrate to the US, the impact of the immigration is to improve US technology (reduce US unit labor requirements) for those \( z \)’s but not cause the \( A(z) \) curve to slope upward over any interval of \( z \)’s in [0,1].

3. (20 points) The *New York Times* ran an article a few years ago with the headline “Falling Wages at Factories Squeeze the Middle Class.” The article begins with:

For nearly 20 years, Darrell Eberhardt worked in an Ohio factory putting together wheelchairs, earning $18.50 an hour, enough to gain a toehold in the middle class and feel respected at work.

He is still working with his hands, assembling seats for Chevrolet Cruze cars at the Camaco auto parts factory in Lorain, Ohio, but now he makes $10.50 an hour and is barely hanging on. “I’d like to earn more,” said Mr. Eberhardt, who is 49 and went back to school a few years ago to earn an associate’s degree. “But the chances of finding something like I used to have are slim to none.”

It may seem puzzling that this drop in US manufacturing wages, which likely reflects increased trade pressures faced by US firms, is occurring now, when US tariffs have been low for some time. Use the 2-good 2-country Ricardian trade model and the 2-good 2-factor 2-country Heckscher-Ohlin model to argue that the increasing flow of technology across countries can help resolve this puzzle. Specifically, please do the following:

a) First, use the Ricardian model and show that, in a world of free trade and with the US producing both goods, the US wage would remain higher than the foreign wage as long as the US technology exhibits an absolute advantage in the good that is also produced by the other (foreign) country.

b) Second, use the Heckscher-Ohlin model and show that, in a world of free trade where the US is the capital abundant country and with both countries producing both goods, the US wage will become equal to the foreign wage if the US absolute advantage is eroded and technologies are the same across countries as the Heckscher-Ohlin model assumes.

c) Finally, using the Heckscher-Ohlin model and again assuming the US is the capital abundant country, show that a US tariff would raise Mr. Eberhardt’s real wage.

Extra Credit (5 points) Pose a question on a trade policy topic that your grandmother might ask you at the Thanksgiving dinner table this Thursday, and provide an answer that is supported by the models we have covered in Econ 39F this Fall but that is translated into words and intuitive explanations that your grandmother could appreciate without having taken Econ 39F herself.
1. We have been asked to consider the link between infrastructure investment and immigration. Specifically, we are asked to investigate whether allowing more openness to immigration may help minimize the economic disruptions that infrastructure investment alone could create. We are told to assume that the US is a small open economy trading freely with the ROW and importing manufactures (M) and exporting food (F), and that infrastructure investment can be modeled as an increase in the US capital stock. Part (a) asks us to use the Specific Factors Model. Part (b) asks us to use the Heckscher-Ohlin Model.

a) We are told to assume that in the short run the US is a Specific Factors Model economy with capital specific to M, land specific to F, and labor mobile between M and F. We are asked to show that in the short run infrastructure investment alone would hurt US landowners, but if the infrastructure investment were combined with the
right amount of labor immigration into the US, the real incomes of both US land owners and US workers could be left unchanged.

The two graphs below show that infrastructure investment alone will hurt US land owners.
As depicted in the graphs on the previous page, infrastructure investment shifts up the VMPL curve by shifting up the MPL curve (as we are told to assume), and this leads to a movement of labor into M and out of F. The bottom figure on the previous page shows the loss in real income to US landowners that results (with the US a small open economy and F and M therefore unaffected, the shaded area is the real loss for US landowners regardless of what they consume).

The figures on the following page show the amount of immigration of labor into the US which, if combined with the US infrastructure investment, would leave the real incomes of both US landowners and US labor unchanged.
As the top graph on the previous page shows, by allowing immigration into the US in the amount $\Delta L$ as depicted, the US wage $W$ that clears the US labor market can be held constant in the presence of the US infrastructure investment ($W_1 = W_0$). And with $W$ held fixed and $P^L$ not impacted, landowners then do not change their labor hiring and hence do not experience any change in their real income measured in units of food as the bottom figure on the previous page shows. And with $P^L$ not impacted either, the real income of landowners is left unchanged no matter what they consume.

Finally, with $W$ not changing and $P^L$ and $P^n$ not changing, the real income of US workers is also left unchanged.

b) We are told to assume that in the long run the US economy in a Heckscher-Ohlin Model economy, producing both capital-intensive Food ($F$) and labor-intensive Manufactures ($M$). We are asked to show that the US industrial mix (the ratio of $F$ to $M$ production) would have to
adjust in the presence of infrastructure investment alone, but that the US industrial mix could be held constant if the infrastructure investment were combined with the right amount of labor immigration into the US.

The graph below shows the change in the US industrial mix that would accompany infrastructure investment alone:
As the graph on the previous page depicts, the added US capital stock from the infrastructure investment raises the US factor endowment from \( F_0 \) to \( F_1 \). In order to fully employ the new US endowment of factors, production in the capital-intensive \( F \) sector must rise from \( q_{F0} \) to \( q_{F1} \) and production in the labor-intensive \( M \) sector must fall from \( q_{M0} \) to \( q_{M1} \), changing the ratio of \( F \) production to \( M \) production and thus the US industrial mix.

The figure on the following page shows the amount of labor immigration into the US which, if combined with the infrastructure investment, would preserve the US industrial mix.
As the graph above depicts, with labor immigration into the US in an amount that keeps the ratio of capital to labor endowments in the US fixed, \( \frac{K_{us}}{L_{us}} \), the US production of M and F will both rise in the same proportion (\( g_{us} \) to \( g_{us} \) and \( 2F_{0} \) to \( 2F_{f} \)), and their ratio, and hence the US industrial mix, will remain unchanged.
2.) We are asked to use the Continuum-of-goods Ricardian Model to show that the impact of immigration into the US could have different implications for the US real wage depending on what industries (which interval of Z) the foreign workers were originally employed in before they emigrated to the US. We are told to assume that immigrants improve the US technology (lower the US unit labor requirement) for the good Z where they were employed in the foreign country.

To show this, we can compare the impact on US real wages of immigrants from two different intervals of foreign industries:

(i) Immigrants that were employed in an inferior marginal range of industries in the foreign country and

(ii) Immigrants that were employed in a marginal range of industries in the foreign country.

We can consider the distinct impact of (i) and (ii) on the purchasing power of the US wage with respect to goods imported from the foreign country both before and after immigration.
(i) The graph below depicts the impact of foreign immigration into the domestic country (US) from foreign workers who worked in infra marginal industries:

\[
B_0(z) = \frac{x_0(z) L_0}{1 - y_0(z) L_0}
\]

\[
B_1(z) = \frac{x_1(z) L_1}{1 - y_1(z) L_1}
\]

Migration lowers the foreign labor force \( (L^* < L_0) \) and raises the home labor force \( (L_1 > L_0) \), thereby shifting down the \( B(z) \) curve. And with immigrants coming from the infra marginal range of industries \( z \in [z_2, z_3] \), we have \( l_1(z) < l_0(z) \) for \( z \in [z_2, z_3] \), shifting the \( A(z) \) curve up over this range of \( z \)'s.
Now let's consider the impact of this in-marginal immigration on the purchasing power of the US image with respect to goods imported from the foreign country both before and after immigration. Let's label such a good a 2" good:

\[
\frac{W_0}{L_0} = \frac{W_0}{W_0^*} = \frac{W_0}{W_0^*} \cdot \frac{L_0}{L_0^*}
\]

\[
\frac{W_1}{L_1} = \frac{W_1}{W_1^*} = \frac{W_1}{W_1^*} \cdot \frac{L_1}{L_1^*}
\]

Hence, \( \frac{W}{L} \) falls in proportion to the fall in \( W^* \) depicted in the graph on the previous page. Now let's consider immigration from workers who worked in a marginal range of industries.

(iii) The graph on the next page depicts the impact of foreign immigration into the domestic country (US) from foreign workers who worked in marginal industries.
Migration lowers the foreign labor force ($L_f < L^*_0$) and raises the home labor force ($L_1 > L_0$), thereby shifting down the $B(Z)$ curve. And with immigrants coming from the marginal range of industries $Z \in [Z_0, Z_2]$, we have $L_1(z) < L_0(z)$ for $Z \in [Z_0, Z_2]$, shifting the $A(z)$ curve up over this range of $Z$s.

Now let's consider the impact of this marginal immigration on the purchasing power of the US wage with respect to...
goods imported from foreign country before borders and after immigration. Let's again label such a good as a \( g \) good.*

\[
\frac{w_0}{p_0(g)} = \frac{w_0}{w^*_0 e^*(g)} = \frac{w_0}{w^*_0 \frac{1}{e^*(g)}}
\]

\[
\frac{w_1}{p_1(g)} = \frac{w_1}{w^*_1 e^*(g)} = \frac{w_1}{w^*_1 \frac{1}{e^*(g)}}
\]

Hence, once again, \( \frac{w}{p(g)} \) falls in proportion to the fall in \( \frac{w}{w_0} \) depicted in the graph on the previous page.

But we can now observe that the marginal immigration (case (ii) graph) leads to a smaller fall in \( \frac{w}{w^*_1} \) than does intra-marginal immigration (case (i) graph), and so marginal immigration reduces the purchasing power of the US wage with respect to the focus range of import goods by less than does intra-marginal immigration.

Hence, what industries the immigrants come from matters for the impact of immigration on the US real wage.
We are asked to interpret the quoted NYTimes article about falling factory wages in the United States through the lens of the 2-good 2-county Ricardian Trade Model and the 2-good 2-factor 2-county Heckscher-Ohlin Model.

(a) We are to first use the Ricardian model to show that with free trade and with the U.S. producing both goods, the U.S. wage remains higher than the foreign wage as long as the U.S. has an absolute technological advantage in the good that they both produce.

The graphs on the next page illustrate the case where the U.S. produces both goods under free trade and the foreign country produces good X.

With both countries producing X in free trade, we must have

\[ \bar{w} \bar{x} = \bar{p} \bar{x} = \bar{W} \bar{x} \]

\[ \Rightarrow \frac{\bar{w}}{\bar{W}} = \frac{\bar{x}}{\bar{x}} \]
And if the U.S. has absolute advantage in $x$, we have

$$l^U_x < l^F_x \Rightarrow \frac{l^x}{l^U_x} > 1.$$ 

So we have

$$\frac{w^U}{w^F} = \frac{l^U_x}{l^F_x} > 1 \Rightarrow w^U > w^F \checkmark$$
6) Next, we are to use the Heckscher-Ohlin Model to confirm that when U.S. and foreign technologies are equalized, and both countries produce both goods, free trade will lead to an equal wage in the U.S. and the foreign country.

This is confirmed with the following graphs:

![Graphs showing wage equality under free trade](image)

We are told that the U.S. is the capital abundant country, so we know by the Heckscher-Ohlin Theorem that the U.S. will export the capital-intensive good. Let's let \( y \) be the capital-intensive good. Then the figures above depict the trade pattern between the U.S. and Foreign under Free Trade. The important
points from these figures is that (i) both countries produce both goods, and (ii) goods prices are equalized. As technologies are the same across countries, this then means that the two countries share unit value is equal, and so we have:

\[ \frac{1}{W^F} = \frac{1}{p^F} \]

As confirmed by this figure, the U.S. wage and the foreign wage are equalized through Free Trade when U.S. and foreign technologies are the same and both countries produce both goods.
Finally, with the U.S. capital abundant we are asked to confirm that a U.S. tariff could raise the U.S. real wage. The relevant graphs are below:

The U.S. tariff raises the relative price of X in the U.S. \( (\frac{P_x}{P_y})_U \geq (\frac{P_x}{P_y})_0 \).

Let's normalize \( P_y = P_y^0 \). Then the U.S. tariff implies that \( P_x^1 > P_x^0 \), or \( \hat{P}_x > \hat{P}_y = 0 \).

The following graph shows what this implies for \( W^U_S \) and \( P_x^S \).
So we have \( \hat{W} > 0 \) and \( \hat{\rho} < 0 \).

Therefore we know that

\[
\hat{p}_x > \hat{p}_y = 0 > \hat{\rho}
\]

and \( \hat{W} > 0 \), which implies we could have

(i) \( \hat{W} > \hat{p}_x > \hat{p}_y = 0 > \hat{\rho} \) or
(ii) \( \hat{p}_x > \hat{W} > \hat{p}_y = 0 > \hat{\rho} \).

But (ii) can be ruled out by the condition that \( \Pi_x = 0 \) before and after the tax, so condition (i) holds and the real wage increases.