Examples Williamson Goes Through:

1. Equilibrium effects of an increase in government expenditures today G_1
2. Equilibrium effects of a persistent increase in government expenditures
3. Equilibrium effects of a decrease in current capital stock K_1
4. Equilibrium effects of an increase in current TFP z_1
5. Equilibrium effects of an increase in future TFP, say z_2
6. Sectoral shock

Example 1: Effect of an increase in G_1

Examples: any temporary changes like fighting a quick war, increased spending due to natural disasters

$\Delta G_1 > 0 \Longrightarrow \nearrow$ in PV of govt expenditures $\Longrightarrow \nearrow$ in PV of taxes as well.

Why?

Government's LBC:

$$\underbrace{G_1 + \frac{G_2}{1+r_1} + ...}_{PV \text{ of expenditures}} = \underbrace{T_1 + \frac{T_2}{1+r_1} + ...}_{PV \text{ of taxes, } \tau}$$

Hence,

$$\Delta G_1 = \Delta\tau$$

$\Longrightarrow \Delta\omega^d = -\Delta\tau < 0$. This implies:

Labour Market:
$N_1^s\left(r_1^*\right)$ curve shifts to the right to $\widetilde{N}_1^s\left(r_1^*\right)$ (ω^d falls and consume less leisure which is a normal good, that is, work more), and

Goods Market:

Supply: Y_1^s curve shifts to the right to $\widetilde{Y}_1^s$ because $N_1^s\left(r_1^*\right)$ shifted to the right

Demand: Two effects:

1. Government spends more:

$$\Delta G_1 > 0$$

2. Because consumer's lifetime disposable wealth has decreased, Y_1^d is affected by a change in consumption:
- direct decrease in C_1,
- magnitude of decrease in C_1? $\Delta\omega^d = -\Delta\tau = -\Delta G_1 < 0$,

$$\Delta C_1 = MPC\Delta\omega^d = -MPC\Delta G_1 < 0.$$

Overall change in Y_1^d?

Recall that we saw in the last lecture for some exogenous ΔE,

$$\Delta Y_1^d = \left(\frac{1}{1-MPC}\right)\Delta E,$$

so here,

$$\begin{aligned}
\Delta Y_1^d &= \left(\frac{1}{1-MPC}\right)(\Delta G_1 + \Delta C_1) \\
&= \left(\frac{1}{1-MPC}\right)(\Delta G_1 - MPC\Delta G_1) \\
&= \left(\frac{1}{1-MPC}\right)\Delta G_1\,(1-MPC) \\
&= \Delta G_1.
\end{aligned}$$

This means that Y_1^d changes by ΔG_1, i.e., Y_1^d shifts out to the right to $\widetilde{Y}_1^d$.

Unambiguously, equilibrium Y_1 increases. But it looks like equilibrium r_1 could increase or decrease.

As temporary change in G_1, effect on lifetime wealth small, so N_1^S and hence Y_1^S don't change by much. And Y_1^d changes by ΔG_1. Since change in lifetime wealth small, so effect on Y_1^d relatively large.

So Y_1^d shifts to the right by more than Y_1^S.

At the original equilibrium interest rate of r_1^*, output demand (point A on $\widetilde{Y}_1^d$) exceeds output supply (point B on $\widetilde{Y}_1^s$). Hence, goods market cannot be in equilibrium. To restore equilibrium, interest rate needs to rise because a rise in interest rate means that consumers want to save more, so they consume less today, C_1 falls (substitution effect of interest rate change dominates), and a rise in interest rate means that the rate of return on alternative asset to firms (bonds) increases, so I_1 falls. Hence, there is a movement along the $\widetilde{Y}_1^d$ curve upwards from point A.

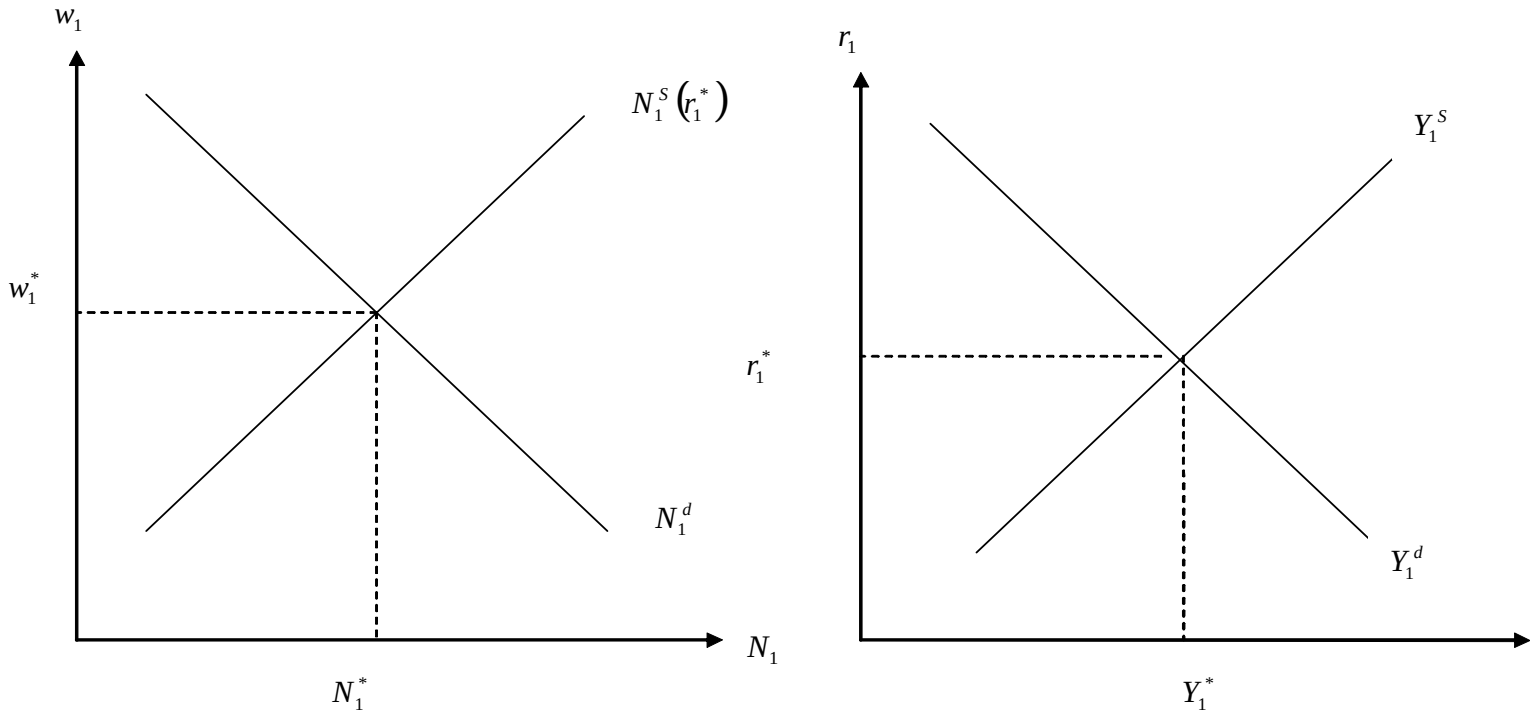
At the same time, as interest rate rises, representative consumer works more, since the price of leisure today is more expensive relative to the price of leisure tomorrow and this substitution effect dominates, so $\widetilde{N}_1^S\left(r_1^*\right)$ starts to shift to the right, and thus causes a movement up along the $\widetilde{Y}_1^s$ curve from point B.

Equilibrium in the goods market is restored when equilibrium r_1 has risen sufficiently so that goods demanded equals good supplied at point C, where the equilibrium r_1 has risen from r_1^* to $\widetilde{r}_1^*$, and equilibrium output increases from Y_1^* to $\widetilde{Y}_1^*$; and in the labour market, $\widetilde{N}_1^S\left(r_1^*\right)$ has shifted to the right to $\widetilde{N}_1^S\left(\widetilde{r}_1^*\right)$, where labour supplied equals labour demanded at the new wage rate which has fallen from w_1^* to $\widetilde{w}_1^*$, and N_1 has risen from N_1^* to $\widetilde{N}_1^*$.

There is a "**crowding out"** effect of G_1 increase on C_1 and I_1 :
- C_1 falls due to $\searrow$ in ω^d, falls due to $\nearrow$ in equilibrium r_1 from r_1^* to $\widetilde{r}_1^*$, so overall: $C_1 \searrow$
- I_1falls due to $\nearrow$ in r_1. Less investment now means lower production capacity in the future.

In equilibrium: a temporary $\nearrow$ in government expenditures leads to a $\nearrow$ in current output, an $\nearrow$ in real interest rate, an $\nearrow$ in current employment, a $\searrow$ in real wages, a $\searrow$ in current investment, and a $\searrow$ in current consumption.

Figure "9.16" An Increase in G_1 on labour and goods market equilibria



Example 2: Effect of a permanent increase in G

Example: permanent terrorist threat, so funding for counter-terrorism measures increases permanently

$\Delta G_1 = \Delta G_2 = \Delta G_t = \Delta G > 0$ for all t means that PV of govt expenditures $\nearrow \Longrightarrow$ PV of taxes $\nearrow$ as well since

$$\Delta G_1 + \frac{\Delta G_2}{1 + r_1} + \frac{\Delta G_3}{(1 + r_1)(1 + r_2)} ... = \Delta \tau$$

$\Longrightarrow \Delta \omega^d = -\Delta \tau < 0$. This implies:

Labour Market:
N_1^s curve shifts to the right from $N_1^s\left(r_1^*\right)$ to $\widetilde{N}_1^s\left(r_1^*\right)$ (because $\omega^d \searrow$)

Goods Market:

Supply: Y_1^S shifts to the right to $\widetilde{Y}_1^S$ because $N_1^s\left(r_1^*\right)$ shifted to $\widetilde{N}_1^s\left(r_1^*\right)$

Demand: 3 effects

1: direct increase from government of ΔG_1

2: we know that the PV of taxes $\nearrow$ by $\Delta\tau$. Because consumer's lifetime disposable wealth has decreased, Y_1^d is affected by a change in consumption: $\Delta\omega^d = -\Delta\tau = -\left(\Delta G_1 + \frac{\Delta G_2}{1+r_1} + ...\right) < 0$,

$$\Delta C_1 = MPC\Delta\omega^d = -MPC\left(\Delta G_1 + \frac{\Delta G_2}{1+r_1} + ...\right) < 0.$$

3. Increase in future real income of

$$\Delta Y = \frac{\Delta Y_2}{1+r_1} + \frac{\Delta Y_3}{(1+r_1)(1+r_2)} + ...$$

Overall,

$$\begin{aligned}
& \Delta Y_1^d \\
= \; & \left(\frac{1}{1-MPC}\right)\Delta G_1 \\
& - \left(\frac{1}{1-MPC}\right)\left[MPC\left(\Delta G_1 + \frac{\Delta G_2}{1+r_1} + \frac{\Delta G_3}{(1+r_1)(1+r_2)} + ...\right)\right] \\
& + \left(\frac{1}{1-MPC}\right)\left[MPC\left(\frac{\Delta Y_2}{1+r_1} + \frac{\Delta Y_3}{(1+r_1)(1+r_2)}...\right)\right] \\
= \; & \Delta G_1 + \left(\frac{MPC}{1-MPC}\right)\left[\frac{\Delta Y_2 _ \Delta G_2}{1+r_1} + \frac{\Delta Y_3 - \Delta G_3}{(1+r_1)(1+r_2)} + ...\right]
\end{aligned}$$

Let us conjecture that $\Delta Y_t = \Delta G_t$ every period from $t \geq 2$. That is, in all future periods, each of those periods' income would increase by the same amount as government spending. If this is so, then

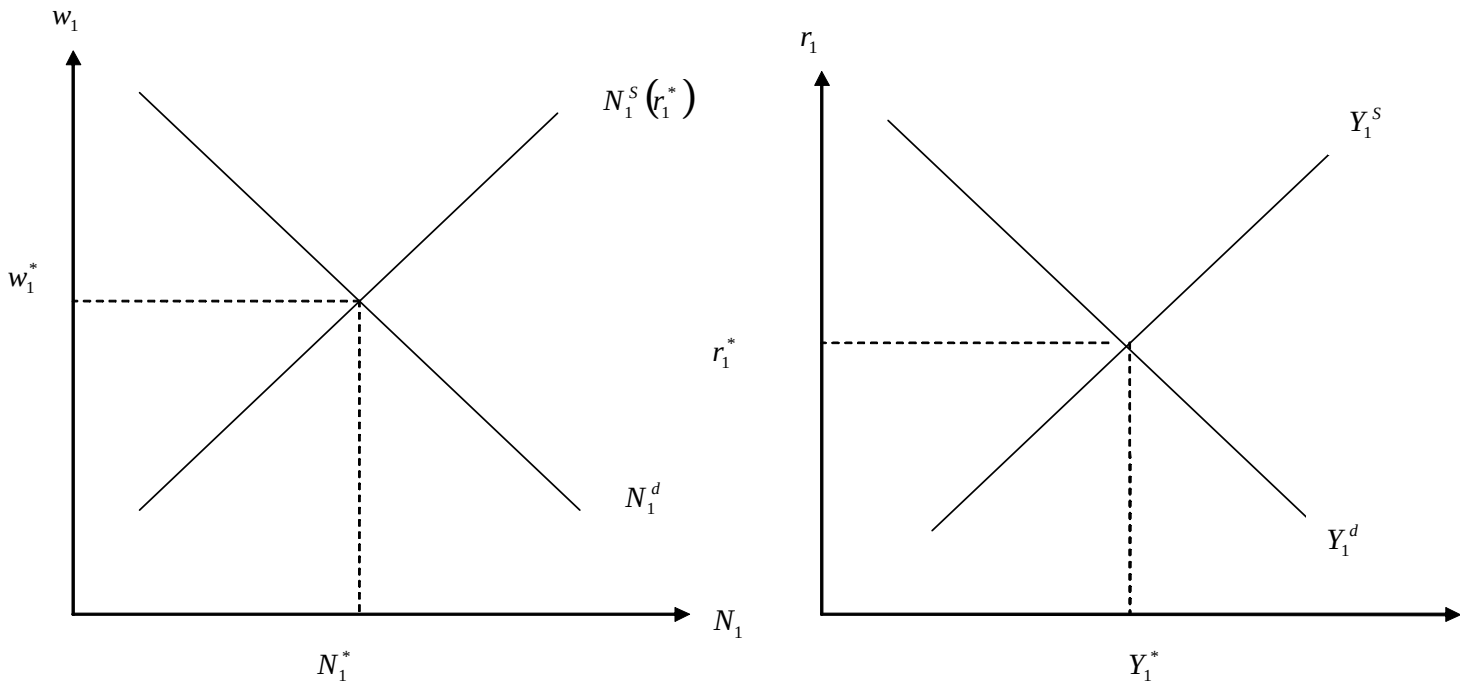
$$\Delta Y_1^d = \Delta G_1 = \Delta G.$$

Since Y_1^d shifted to the right to $\widetilde{Y}_1^d$, and Y_1^S shifts to the right to $\widetilde{Y}_1^S$, real output today must have increased, though it appears that r_1 may rise or not. However, r_1 does not change, because the change in government expenditures is permanent, so consumption every period is affected in the same way, and hence, there is no incentive to change savings to smooth consumption over time, implying no change in credit market. Hence, r_1 remains unchanged, and $\Delta Y_1 = \Delta Y_1^d = \Delta G$. Since there is no change in investment, no change in future capital stock. Hence, nothing in the future has changed except that for all future periods only government expenditures change, so it must be that in all future periods $\Delta Y_t = \Delta G_t$, which proves the conjecture.

In equilibrium: a permanent $\nearrow$ in government expenditures leads to:
real current output $\nearrow$, real interest rate is unchanged, consumption is unchanged, investment is unchanged, real current wage rate has $\downarrow$, and current employment $\nearrow$

So here, no crowding out effect. C_1 and I_1 remain unchanged. The entire cost of permanent change in government expenditures has resulted in a decrease in leisure, where the representative consumer worked harder to support higher government spending.

Figure "9.18" A Permanent Increase in Government Expenditures on equilibria in Goods and Labour markets



Example 3: Effect of an increase in z_1

Examples: favourable weather, favourable change in government regulations; basically any factor that allows you to produce more with the same amount of inputs for a short period of time.

When $\Delta z_1 > 0$

Labour Market:
N_1^d shifts to the right from N_1^d to $\widetilde{N}_1^d$ because $MPN_1 \nearrow$ and firm increases demand for labour

Goods Market:
Supply: Y_1^S shifts out to $\widetilde{Y}_1^S$ due to N_1^d shifting out from N_1^d to $\widetilde{N}_1^d$
Demand: no change in Y_1^d

At the original equilibrium interest rate of r_1^*, output demand (point A on Y_1^d) is less than output supply (point B on $\widetilde{Y}_1^s$). Hence, goods market cannot be in equilibrium. To restore equilibrium, interest rate needs to fall, because a fall in interest rate means that consumers want to save less, so they consume more today, C_1 increases (substitution effect of interest rate change dominates), and a fall in interest rate means that the rate of return on alternative asset to firms (bonds) decreases, so I_1 increases. Hence, there is a movement along the Y_1^d curve downwards from point A.

At the same time, as interest rate falls, representative consumer works less, since the price of leisure today is less expensive relative to the price of leisure tomorrow and this substitution effect dominates, so $N_1^S\left(r_1^*\right)$ starts to shift to the left, and thus causes a movement down along the $\widetilde{Y}_1^s$ curve from point B.

Equilibrium in the goods market is restored when equilibrium r_1 has fallen sufficiently so that goods demanded equals good supplied at point C, where

the equilibrium r_1 has fallen from r_1^* to $\widetilde{r}_1^*$, and equilibrium output increases from Y_1^* to $\widetilde{Y}_1^*$.

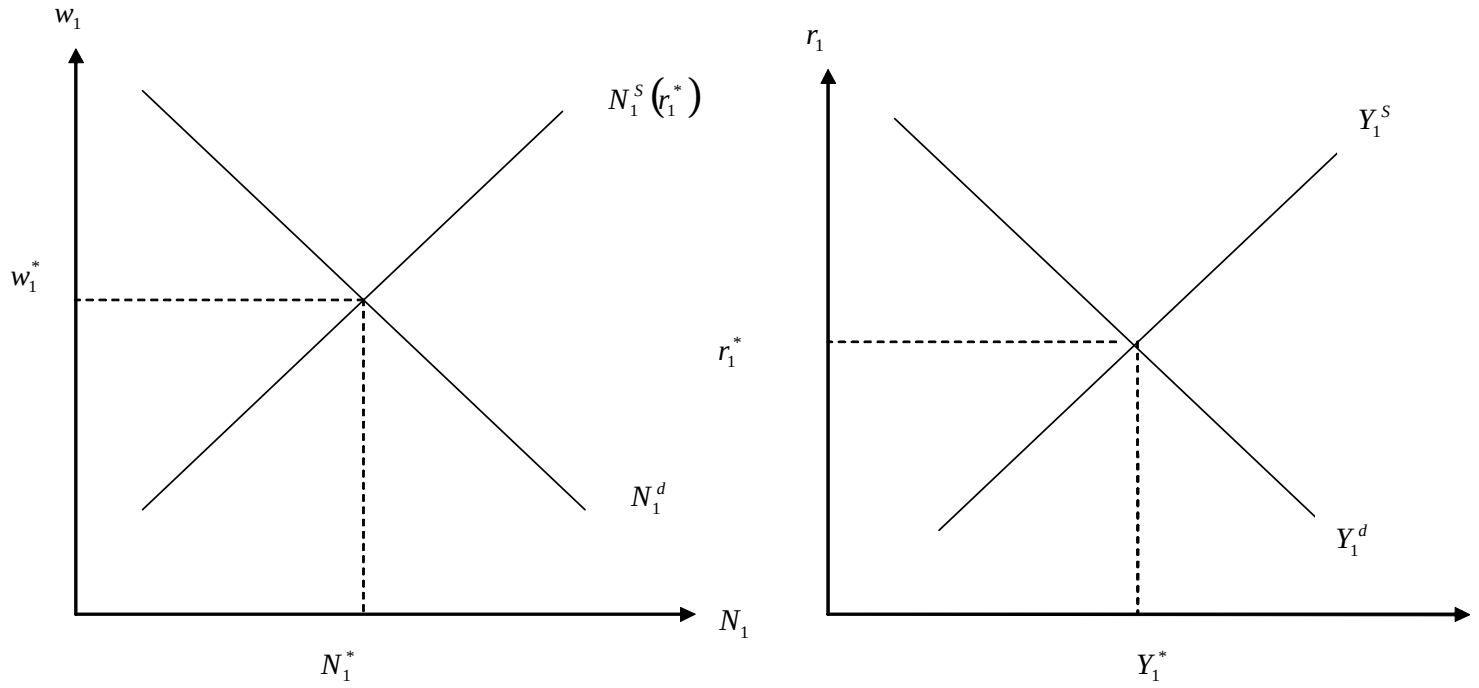
But in the labour market, as interest rate rises, labour supplied falls from $N_1^s\left(r_1^*\right)$ to $\widetilde{N}_1^s\left(\widetilde{r}_1^*\right)$. Equilibrium wage rate rises unambiguously from w_1^* to $\widetilde{w}_1^*$, but the net effect on current employment is ambiguous
But data tells us that real interest rate effect on labour supply is small, so overall, employment will rise from N_1^* to $\widetilde{N}_1^*$.

Story: increase in z_1 increases labour demand from N_1^d to $\widetilde{N}_1^d$, so movement along the labour supply curve $N_1^s\left(r_1^*\right)$ means an increase in wages as well as higher current employment. This then increases the quantity of goods that can be supplied in the goods market, as labour supply increases from Y_1^s to $\widetilde{Y}_1^s$. This causes a fall in real interest rate from r_1^* to $\widetilde{r}_1^*$, resulting in a decrease in labour supply from $N_1^s\left(r_1^*\right)$ to $N_1^s\left(\widetilde{r}_1^*\right)$, which is smaller than the increase

in labour demand. Consequently, real wages and current employment rise in the labour market. In the goods market, consumption increases following the fall in interest rate and increase in current income, and investment rises due to the fall in interest rate. In equilibrium in the goods market, the increase in output demanded via increasing C_1 and I_1 equals the increase in output supplied (movement along the Y^d curve as Y^s rises).

Note: later on, we will see that temporary shocks to TFP is a good candidate in accounting for business cycle fluctuations.

"Figure 9.21" Change in z_1 on equilibria in Goods and Labour markets



Example 4: Effect of an expected increase in future TFP, say z_2

Let $\Delta z_2 > 0$

Examples: anticipate new sources of fuel, anticipate new production processes that make production more efficient in the future.

Goods Market:
increase in z_2 means higher MPK_2, so higher return to investment, so I_1 increases
investment component of $Y_1^d \nearrow$, so $Y_1^d \nearrow$ from Y_1^d to $\widehat{Y}_1^d$

Recall that $w_1 = MPN_1 = z_1 F_2(K_1, N_1)$? Likewise, tomorrow, $w_2 = MPN_2 = z_2 F_2(K_2, N_2)$

$\nearrow$ in tomorrow's wage means $\nearrow$ in lifetime wealth $\Rightarrow \nearrow$ in today's consumption, so consumption component of Y_1^d $\nearrow$, and multiplier effect, so let Y_1^d shift further out from $\widehat{Y}_1^d$ to $\widetilde{Y}_1^d$

Labour Market:
- increase in ω^d implies N_1^s shifts in to $\widetilde{N}_1^s(r_1^*)$, but this causes a leftward shift of Y_1^S to $\widetilde{Y}_1^S$.

As the increase in wealth is small, this leftward shift of Y_1^S to $\widetilde{Y}_1^S$ is small relative to the rightward shift of Y_1^d to $\widetilde{Y}_1^d$.

At the original equilibrium interest rate of r_1^*, output demand (point A on $\widetilde{Y}_1^d$) exceeds output supply (point B on $\widetilde{Y}_1^s$). Hence, goods market cannot be in equilibrium. To restore equilibrium, interest rate needs to rise because a rise in interest rate means that consumers want to save more, so they consume less

today, C_1 falls (substitution effect of interest rate change dominates), and a rise in interest rate means that the rate of return on alternative asset to firms (bonds) increases, so I_1 falls. Hence, there is a movement along the $\widetilde{Y}_1^d$ curve upwards from point A.

At the same time, as interest rate rises, representative consumer works more, since the price of leisure today is more expensive relative to the price of leisure tomorrow and this substitution effect dominates, so $\widetilde{N}_1^S\left(r_1^*\right)$ starts to shift to the right, and thus causes a movement up along the $\widetilde{Y}_1^s$ curve from point B.

Equilibrium in the goods market is restored when equilibrium r_1 has risen sufficiently so that goods demanded equals good supplied at point C, where the equilibrium r_1 has risen from r_1^* to $\widetilde{r}_1^*$, and equilibrium output increases from Y_1^* to $\widetilde{Y}_1^*$.

In the labour market, the small wealth effect must be dominated by the rightward shift of labour supply through an interest rate change, so the rightward shift of $\widetilde{N}_1^S\left(r_1^*\right)$ to $\widetilde{N}_1^S\left(\widetilde{r}_1^*\right)$. This is because Y_1^* increases to $\widetilde{Y}_1^*$, and since z_1 and K_1 have not changed, an increase in current output must be through an increase in current employment. Hence, labour supplied equals labour demanded at the new wage rate which has fallen from w_1^* to $\widetilde{w}_1^*$, and N_1 has risen from N_1^* to $\widetilde{N}_1^*$.

In equilibrium: an expected increase in future TFP leads to $\nearrow$ in real interest rate and $\nearrow$ in current output, an $\nearrow$ in current employment, a fall in equilibrium wages, and an $\nearrow$ in current investment. Overall effect on current consumption is ambiguous.
- Current investment $\nearrow$ because even though it falls due to $\nearrow$ in real interest rate and rises due to an $\nearrow$ in z_2, overall investment must have risen because that was the original shock to the economy.
- Consumption is ambiguous because it falls due to $\nearrow$ in real interest rate, rises to to $\nearrow$ in current income, and rises due to $\nearrow$ in future income

Figure "9.22" Equilibrium effects of an expected change in z_2